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THE EPIDEMIOLOGY OF PELLAGRA IN NASHVILLE, TENNESSEE *

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INTRODUCTION

During the past two years the public health officers of the city of Nashville have had to deal with a startling and ominous increase in the morbidity and mortality from pellagra. In certain well-defined areas of the city particularly, the disease has been prevalent to an extent involving an economic loss of considerable magnitude quite apart from the physical suffering entailed.

The present facilities for the study and the relief of the situation available to any one of the public health bodies—state, county, or city—being inadequate, it was suggested that these officers co-operate with members of the department of medicine of Vanderbilt university. As a result, a committee met on July 25 at the offices of the city board of health and organized a pellagra commission

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constituted as follows: James W. Jobling, M.D., chairman; Olin West, M.D., of the state board of health, secretary; B. G. Tucker, M.D., county health officer; Wm. E. Hibbett, M.D., city health officer; and William Petersen, M.D. We wish to acknowledge our particular indebtedness to Dr. B. G. Tucker, whose extensive experience has been invaluable in the work of the survey, and in the preparation of this report.

Since no funds were available for this work, the voluntary assistance of several physicians connected with Vanderbilt university was secured. The members of the commission wish to acknowledge the generous co-operation of the following in this connection: Doctors Aycok, Briggs, Costen, Eggstein, Gregory, and Herbert, through whose efforts alone the present survey has been made possible.

Because of the limited number of workers and the lateness of the season (active work was commenced August 1), it was deemed expedient to make a survey of approximately only half of the city, including sections in all parts of the city—inclusive of the so-called residential parts as well as those districts inhabited by people economically less fortunate.

The members of the commission had no preconceived theory concerning the etiology of pellagra or of its mode of transmission. A questionnaire, as follows, was therefore prepared embodying all points which might throw some light on these phases of the subject.

QUESTIONNAIRE USED IN THE STUDY OF THE EPIDEMIOLOGY OF PELLAGRA

1. Name.....Age.....M. F., C. W., M. S., W. D.
2. Address..... Street..... Ward.....
3. Date of examination.....
4. Examination of Patient.
 - (a) Determine exact time of onset (month and year), the first symptom noted (whether gastro-intestinal, mental or skin change), and the sequence of these.
 - (b) History and exact time of later attacks.
 - (c) The present condition of patient and the type of symptoms.
 - (d) Present occupation. Occupation during the past five years and at time of first attack. The present economic condition—earning capacity, number of dependents, etc.
 - (e) Residence when first attack was noted (in detail); give details for the past five years, including street numbers.
 - (f) History of previous illness (if severe). Evidence of hookworm?
5. Exposure to Disease.
 - (a) Cases in immediate family. Onset of the first case? Type? Time of appearance and age of patient?
 - (b) Cases among distant relatives? Contact with them?
 - (c) Cases in immediate neighborhood or among friends?
 - (d) Exposure due to occupation; visits?
 - (e) Have there been previous cases in the same house?
 - (f) What was the first case the patient has knowledge of?
 - (g) How many brothers or sisters living? Dead?
6. Type of food.
 - (a) Amount, number of meals, appetite?
 - (b) Type of food? Protein, carbohydrate, fat?
 - (c) Preference?
 - (d) Is food properly prepared?
 - (e) Change in type of food during the past five years?
 - (f) Milk supply, name of dealer or source?
7. Type of Domicile.
 - (a) House, number of rooms occupied, number of people living in house?
 - (b) Type of sleeping quarters, number in room?
 - (c) Frame, stone or brick?
 - (d) Bath in house? How often used?
 - (e) Toilet in house?
 - (f) Screening?
 - (g) Domestic animals?
 - (h) Rats? Mice? Fleas?

8. Sanitation.
 - (a) Connection with city sewage when illness began?
 - (b) Open or closed privy? Distance from house?
 - (c) Was privy used by other pellagrins?
 - (d) Water supply. City? Well? Describe whether dug or drilled, bucket or pump, covered with wood or concrete. Spring? If from well or spring, give the exact address and location.
 - (e) How garbage disposed?
 - (f) Is there standing water on the premises?
9. Clothing and Light Exposure.
 - (a) Is patient exposed to much light in occupation?
 - (b) Kind of clothing. Colors of preference?
 - (c) Shoes?
10. Personal Observations of Examiner.
 - (a) Cleanliness of patient and home?
 - (b) Insects? Body or head lice?
 - (c) Apparent physical condition of family?

In addition, as each examiner went from house to house, he made note of the number of inhabitants, their race, and their approximate ages, and of the sanitary conditions, so that for the areas surveyed rather complete data are available concerning the population and sanitation.

In addition to this source of information there were available for study the records of the city, county, and state health offices.

Pellagra has been a reportable disease since 1911; the morbidity records are, however, of little use for statistical purposes for the following reasons: A considerable number of the cases are not seen by physicians; some are seen by physicians who even today insist that no such clinical entity as pellagra exists, and who persist in classifying and in treating these cases as "weeping eczema," "tetter," "seven-year itch," "nervousness," "amebic dysentery," "tabes mesenterica," etc.; certain other cases which occur in the more fortunate strata of the social organizations are purposely not reported because even physicians have gradually assumed an attitude of condonation toward the American habit of applying the law differently to the wealthy and to the poor.

The mortality records are undoubtedly of greater value, but err in that a large number of cases dying from pellagra have been recorded as dying from the complications or simple manifestations of the disease, no mention being made of pellagra itself. Even at the present time some 40 to 50% of the cases of pellagra are not so diagnosed on the death certificate. According to the statistics of the state board of health, about 600 cases of pellagra died during the year 1914 in the state of Tennessee.

In addition to the work outlined, the members of the commission have investigated several of the public institutions connected with the community life, and have made two additional surveys—one of a rural district in the same county of which Nashville is the county seat, and one in a small city about 40 miles from Nashville. Several etiologic studies have been conducted at the laboratories of the department of pathology of Vanderbilt university, of which a report will be issued later.

The members of the commission desire to express their appreciation of numerous courtesies from the members of the profession in Nashville and in particular from the following: Doctors Core and Lentz of the Davidson county asylum; Doctors McCabe, Manier, and Weaver of the city, Vanderbilt, and industrial school hospitals respectively; Doctors Douglas, Ragsdale, and Francisco of the Central state asylum; to Mr. Denton, chairman of the state board of control, and to Mrs. Boydston of the West Nashville free clinic.

It is the purpose of the commission to extend and complete the survey during the next spring and summer, the present report being published in the hope that the collection of data and the deductions that can possibly be drawn from them will be of sufficient value in view of the urgency of the situation and the growing interest of investigators and the medical profession as a whole in this disease.

DESCRIPTION OF NASHVILLE

Nashville, the capital of the state of Tennessee, is a city of approximately 115,000 inhabitants, about one-third of whom are colored. The city is located a little north of the central part of the state, lies on both banks of the Cumberland river, the older and chief commercial center being west of the river. This portion of the city is roughly divided into 3 parts; the northern part extending out into the lowland in the great bend of the river, the western part reaching to the river at the lowest segment of this bend, and the southern part of the city extending along the banks of the river and to the heights directly south and southwest of the city—Fort Negley, reservoir, etc. (see Chart 1). The city proper covers approximately 18.3 square miles.

Topography.—The city is built on a horizontal bed of limestone, the frequent outcropping of which, through the shallow subsoil, has given rise to the term "Rock City." To the south and west rise a series of hills forming part of the boundary of the central basin of Tennessee; these reach an altitude of possibly 500 feet above the level of the city and extend between the bends of the river previously referred to. From them small streams arise, which empty into the Cumberland; the valleys of these streams divide the city into 3 ridges, each terminating in a rock bluff on the river (Chart 10, p. 535). These streams—Lick, Wilson, and Brown's creek—form the basis of the sewage system of the part of Nashville west of the river. A single stream divides the eastern part of the city and forms the basis of its sewage system.

Distribution of Population.—The great bulk of the population lives in single detached houses and cottages of 3 or 4 rooms. The congestion of population in a small area in tenements such as occurs in the larger industrial centers of this country, does not exist in Nashville. The population is almost wholly native born, the greater part of the industrial class being drawn from the hill country immediately adjacent to the city. This element having been raised under conditions where sanitation is a negligible quantity (approximately

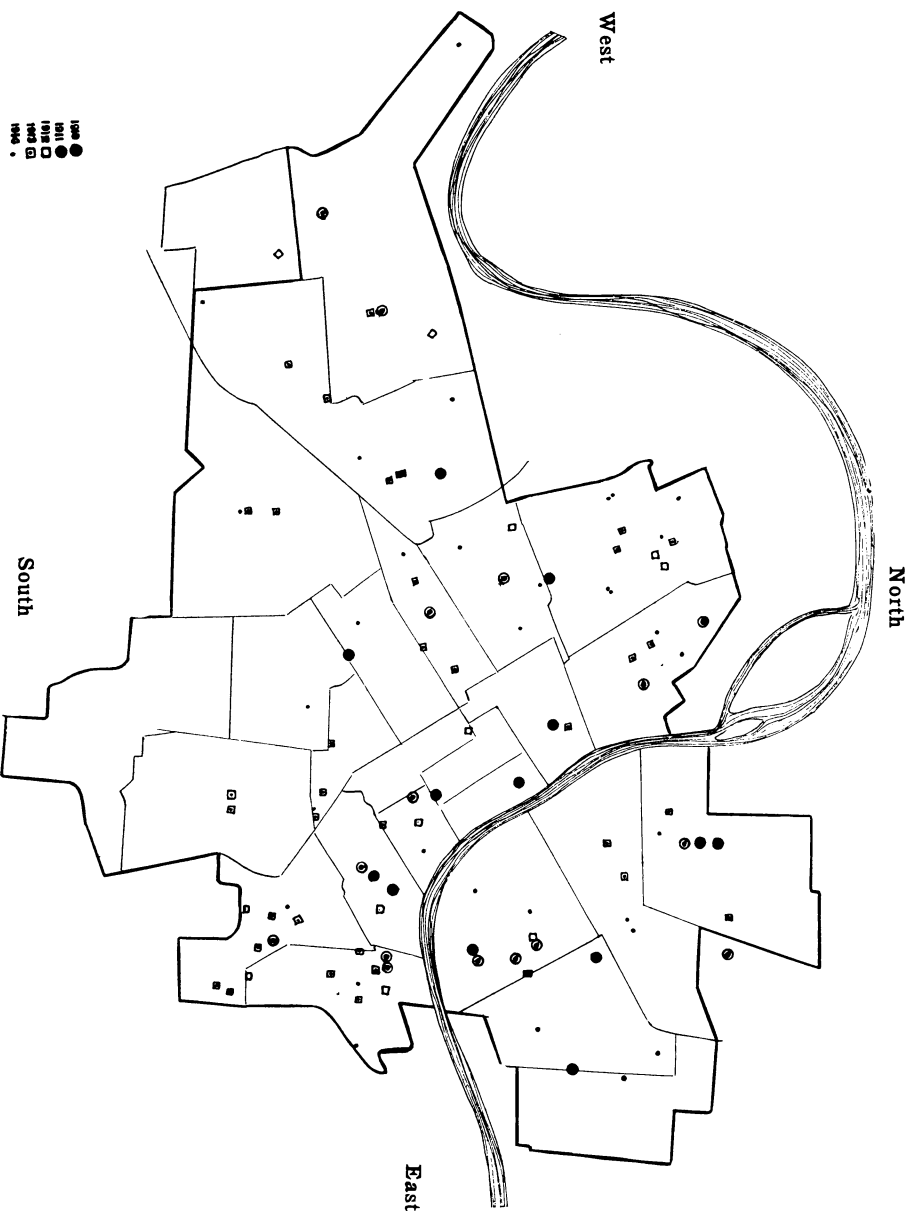


Chart 1. Ward map of the city of Nashville, showing morbidities from pellagra each year from 1910 to 1915, as reported to the city health office.

80% of the rural houses are even without privies) is quite content with the most primitive measures of sanitation provided in certain sections of the city. The white population is drawn almost wholly from older English, Scotch, as well as Colonial, immigration into the region from the Virginias and the Carolinas.

The colored population, numbering from 30,000 to 35,000, lives scattered over the city in rather well-defined groups, altho there is no legal segregation. The bulk of this population lives in the unsewered parts of the city, but their section of the city differs from that occupied by the whites in being at rather higher levels, which, despite the lack of sewerage, are well cleaned and flushed by every rainfall. The only exception is that part of the city known as "Black Bottom" (12th ward—Chart 2, p. 514), but in this low-lying area sewerage has been largely provided.

Economic Conditions.—The demand for labor is precarious, the wages are low and the family income is augmented, and in many instances almost wholly provided, by the labor of the children of the family. The opportunity for such employment is offered by several cotton and weaving mills, snuff factories, and similar establishments. More remunerative employment is offered for skilled labor in lumbering and woodworking, as well as in fertilizer mills, foundries, and railroad shops.

Economically, the average colored family is on a par with the poorer white families, for while the income may be somewhat less, the living expenses are lower in proportion, and the negro woman, while wasteful, is nevertheless frequently a good cook, so that the family is well nourished. The personal hygiene of the negro is equal to, and in some instances far superior to that of the average poorer white family.

Temperature.—The mean annual temperature of Nashville is 59 Fahrenheit, with an annual precipitation of 47 inches. The relation of morbidity to temperature is illustrated in Chart 9, on p. 533. It is true that the high temperature of the summer is of rather long duration and is occasionally very high (maximum 104); nevertheless the humidity during the summer months is usually low, so that heat prostration and death from such cause are practically unknown.

Water Supply and Sewerage.—The fundamentals of sanitation—water supply and sewage-disposal—have been provided in Nashville, but unfortunately for the health of the community, provided for only

part of the population, and of the two, the water supply has been extended to a greater number than the proper means of sewage-disposal.

The water is secured from the Cumberland river at a point about 4 miles above the center of the city, just below the entrance of Mill creek. After treatment with aluminum sulfate, sedimentation is permitted, and later further treatment with hypochlorite of lime is carried out. The reservoir is located in the southwestern portion of the city. This supply is augmented in certain parts of the city by numerous more or less superficial wells, which, unfortunately, are situated in those regions where soil-pollution occurs to the greatest extent. A number of springs are also highly esteemed in several of these regions; one of these is situated within 10 feet of an open sewer (Brown's creek) draining an area populated by some 10,000 people.

The sewerage system has developed from and follows the topography of the city, being entirely a gravity system. Because of the very shallow soil and the superficial nature of the limestone strata a rather unfavorable condition is brought about both in connection with the lack of proper filtration of surface waters and in the very considerable expense of the construction of needed lateral sewerage. The sewered area (Charts 10 and 11, pp. 535, 537) includes the older portion of the city, and, in a general way, the southern and southwestern parts of the city west of the river, and the areas of greatest density of population east of the river.

Even in the parts of the city where trunk sewerage has been provided, there are numerous blocks where lateral sewers are lacking and privies are used. It is reliably estimated that there are 12,651 privies in use within the corporate limits, practically all of which are in an unsanitary condition—only a very small number being screened. The fact that in one district alone (North) in an area of about 1 square mile 1500 privies were found (police survey), gives an approximate idea of the amount of surface-pollution. This area is of course that in which both typhoid and diarrheal disease and pellagra are found most prevalent (Charts 11, p. 537, and 13, p. 541).

HISTORY OF PELLAGRA IN NASHVILLE

Pellagra has given the public health workers of Tennessee grave concern since 1911, the year when the disease began to be reported from widely different sections with rapidly increasing frequency. It

was in 1908 that the first cases which had ever been definitely diagnosed as pellagra were seen in Davidson county, these having occurred in the Baptist orphanage, an institution located just outside the limits of the city of Nashville. In 1909 a case was discovered in a man living in a house located on Hydes Ferry turnpike, a few miles northwest of Nashville. This man died at the Davidson county isolation hospital in 1909. An incident worth relating in connection with this case is that a woman who lived next to him and who washed his clothing developed pellagra in the year 1909. About the time that this case was found, another man, residing in a community near the corporate limits of Nashville called Flat Rock, was found with a well-marked case of pellagra. All these cases were seen by Dr. Tucker and Dr. West of the pellagra commission and by numerous physicians in Nashville, to whose daily practice pellagra was a disease hitherto unknown.

The first case of which we can find record as having occurred in the city of Nashville was a woman residing on Joseph street, in East Nashville, in 1911. In this same year the first case of record was found in North Nashville, but it was not until 1914 that the first case was reported from West Nashville, this being the section in which the Baptist orphanage referred to, was located and which has now become a part of the city proper. In 1911 and 1912 reports of pellagra in Nashville and in Davidson county began to be received by the respective health departments in numbers sufficient to make it apparent that the disease was rapidly becoming a very serious menace to the public health.

Late in 1910 and early in 1911 reports were received at the office of the state board of health in Nashville with such frequency as to indicate that pellagra was becoming prevalent in a number of the counties of the state, principally east and middle Tennessee counties. In the spring of 1911 the state board of health added pellagra to the list of reportable diseases, and in July, 1911, adopted a resolution advising the isolation of pellagra patients. At this time, also, a pellagra commission, composed of three physicians, Wm. Krauss, B. S. Rhea, and J. C. Brooks, was appointed to visit those counties in which it appeared that pellagra was at all prevalent, to make such investigations as they saw fit, and to offer such advice as they could give for the proper treatment and control of the disease. This commission, during the summer of 1911, visited a number of counties—about one-third of all in the state—and secured records of about 350 cases. It appears from their report, submitted later in the year 1911, that the disease was most frequently found in the counties in east Tennessee and that there was more of it in middle Tennessee than in west Tennessee. This seems still to be true in 1916.

The cases at the Baptist orphanage in West Nashville were 17 in number and were all in children. It seems that 4 children of one family were received at the orphanage from a county of middle Tennessee in 1907. One of these children, a boy, probably had the eruption of pellagra when admitted to the orphanage. In 1908 the other children of this family group developed skin eruptions and were seen by Dr. J. M. King, of Nashville, to whom credit must be given for making a diagnosis of pellagra, a disease until then unknown in the experience of Nashville physicians. The diagnosis in these cases was confirmed in 1909 by Dr. C. H. Lavinder, of the U. S. Public Health Service, who was at that time in charge of the government work on the causation of pellagra. After the development of the cases in all the children of this one group, 13 other inmates of the orphanage were the subjects of pellagra, presenting well-marked skin symptoms, more distinct in some than in others. These children were isolated in a cottage and thereafter no other cases developed in the orphanage. Those affected were later removed to the Davidson county isolation hospital and 2 of them died. All the others recovered and, as far as is known to us, have remained well. One of these children later went to live in a home located some miles northwest of Nashville on the Hydes Ferry road and after the beginning of this residence 4 or 5 cases of pellagra developed in this immediate community.

While Dr. Lavinder was in Nashville, we had the pleasure of going with him on a visit of inspection to the Central hospital for the insane, the inmates of which are received from the counties of middle Tennessee. A thorough inspection of the patients was made and in none of them was there found any evidence of pellagra. A like visit to the Davidson county asylum, an institution in which indigent and insane persons are cared for to the number of 400 or more, failed to reveal any evidence of pellagra. No cases of pellagra in institutions in and around Nashville were reported until some time after the occurrence of the cases referred to.

Since 1910 one of us (West) has been in charge of the work in rural sanitation of the Tennessee state board of health, having from 3 to 5 associates engaged in field work in the various counties of the state. When this work was begun in the spring of 1910, the field men were instructed to be on the lookout for pellagra and to secure fecal specimens from every case, if possible, for the purpose of determining the coincidence of intestinal parasitic disease with pellagra

Dr. T. B. Yancey Jr., working in Knox county, found 5 cases of pellagra in that county in 1910, from which fecal specimens were secured for microscopic examination. Three of these were positive for hookworm ova, and as in other counties cases of pellagra were found in which hookworm infestation was found in about the same proportion (most of whom improved very markedly after successful treatment for hookworm disease and for disease due to other intestinal parasites), we were greatly interested in the subject of pellagra and made an effort to find as many cases of the disease as possible. Dr. Yancey heard of other cases in Knox county, but the disease was not so prevalent in the year 1910 as to cause the feeling of alarm which developed in the next year.

In 1911, in Knox county, Dr. Yancey, Dr. G. W. Booker, then health officer of Knox county, and one of us (West), went with Dr. Harrell to see a number of his patients who showed well-marked symptoms of pellagra. Dr. Harrell asked that we see his patients because his statement to the effect that he had 16 cases was disbelieved by other physicians in Knox county. There was no doubt as to the correctness of Dr. Harrell's diagnosis. While he had an unusual number of pellagra patients under his care, this incident well illustrates the rapidity with which the disease made its appearance in numerous homes after one or two cases had occurred in a community in a preceding year. Since 1910 pellagra has become more and more prevalent in Knox county each year.

One of the first cases seen by either of us in middle Tennessee outside of Davidson county was in a young woman, one of a family of 11, in Van Buren county in 1910. This woman was a patient of Dr. R. E. Lee Smith's, of Doyle, and hers was the first case which had occurred in his practice. Dr. Smith invited Dr. W. J. Breeding, then one of the field men of the state board of health, to see the case, and one of us (West) went to Van Buren county to investigate the diagnosis. This patient was very ill and none of us thought she would live more than a few days. The whole family of which she was a member were victims of heavy hookworm infestation. The woman with pellagra was given treatment for hookworm disease; she expelled several hundred parasites, and recovered her health. At our last report, in 1914, she was still well. This family was in very poor circumstances and it was not possible to have provided for the young woman a well-balanced and nourishing diet.

In 1911, when reports received by the state board of health began to indicate a rapid spread of pellagra, a report was received from Scott county of a family of 10 persons, all of whom were thought to have pellagra. Dr. J. A. Albright, then secretary of the state board of health, went to Scott county, saw these persons, and confirmed the diagnosis. Examination of specimens of feces from these cases showed hookworm ova in 8, and ova of *Ascaris lumbricoides* in 2 young children. Treatment for the expulsion of the intestinal parasites resulted in bringing about a disappearance of all symptoms of pellagra.

In 1912 we saw the first case of pellagra which had been diagnosed among the inmates of the Tennessee industrial school, a state institution near Nashville with about 800 inmates, received from all Tennessee counties. The patient was a boy. This case resulted fatally in 1913. In 1913 we saw the first case in the girls' department of this institution, in a girl from Fentress county. She was in a typhoid state and her recovery was not hoped for. She was removed to the Davidson county isolation hospital and, microscopic examination of the feces having discovered a heavy hookworm infection, was given thymol, with the result that her pellagrous symptoms quickly cleared up. A liberal nourishing diet was provided for this patient, but in spite of it the symptoms of pellagra reappeared in aggravated form after a short time. Another treatment with thymol effected the complete disappearance of all symptoms and after a few weeks the girl was returned to the school, where she now is and where her record has been a most excellent one. In 1913 several additional cases of pellagra occurred at the industrial school and it was feared that the disease would become prevalent. Isolation of all cases, however, seemed to stop its spread, for no additional cases developed that year. This experience recurred in 1914, isolation again apparently stopping the spread of pellagra after several well-marked cases had developed in that year. In 1915 fewer cases were noted in the school.

The Central hospital for the insane, the institution which was visited by Dr. Lavinder in 1909, has persistently refused to receive pellagrous patients. There were no cases in this institution, so far as is known, until 1914, except one, this patient having been sent home within a very short time after being received, when symptoms developed. In 1915 there were several cases of pellagra in this insti-

tution. Other hospitals for the insane in Tennessee have not been so strict in refusal of pellagrous patients and we are informed that each of them has had a number of cases. Dr. Core, superintendent of the Davidson county insane asylum, states that there were 2 patients in this institution in 1905 who presented typical symptoms of pellagra, but the disease was not recognized at that time. Since 1909, however, this institution has had a number of cases.

The history of pellagra in and around Nashville, and, for that matter, in Tennessee, has been made since 1907 or 1908. If pellagra occurred prior to those years, none knew its nature and certainly it was an extremely rare condition. At the present time, while the number of cases in Tennessee can only be guessed at, it is probable and practically certain that it is in the thousands.

As we have been engaged in public health work for a number of years, we have had abundant opportunity to see pellagra whenever it has been present in any considerable number of cases. In the years between 1900 and 1909—the latter year yielding, at the Baptist orphanage, the first cases of pellagra ever so diagnosed in Davidson county—neither of us had seen the disease. Since 1909, we have seen the rapid yearly increase which has brought the total number of cases in Davidson county to a figure that is most alarming. By reason of our duties in connection with the departments of health of Nashville and Davidson county, we were called on to vaccinate many thousands of persons during the years 1900 to 1910. In addition, we were called on daily to see patients in the practice of physicians of Nashville and Davidson county who had some form of skin eruption. We should be unwilling to make a definite assertion as to the number of persons we have vaccinated, but there could not have been less than 25,000 and we are confident that a much larger figure would do no violence to the facts. Smallpox was prevalent in Nashville in the very city wards in which pellagra has since become prevalent, and in several years the work of vaccination was carried on through the summer months; consequently, the fact that pellagra is a disease with a summer “up-curve” does not destroy whatever of value is to be attributed to any observations which we may have made. In all the thousands of instances in which we were called to vaccinate on the patients’ arms or legs—the very parts on which the eruption of pellagra is most often found—neither of us can recall having seen any eruption resembling that with which we have since

become familiar as the eruption of pellagra; in all the many persons whom we were called to see with other physicians for the purpose of excluding or making a diagnosis of smallpox or of some other eruptive disease, we saw no case of pellagra prior to those seen in the Baptist orphanage in 1909; in visits of inspection to many industrial plants and institutions of various kinds, we saw no pellagra until 1909. Since then, and more especially since 1911, we have seen an annually increasing number of cases among the very classes, for the most part, among whom we had such abundant opportunity for finding the disease, had it existed, from 1900 until 1909.

It has been our observation that one case of pellagra in a community has practically always been followed by others, either in the same year or during the next season. The correctness of this observation is most certainly confirmed by the nature of reports from practically every community in which pellagra has appeared.

The morbidity from pellagra in Nashville as reported to the city health office for the years 1910 to 1915 is shown in Chart 1 on p. 505.

DISTRIBUTION OF PELLAGRA

The surveyed area included 14 of the 25 wards of the city together with a small area lying southwest of the city limits and forming part of the 8th sanitary district (Chart 2). This area is inhabited by approximately 65,000 people. Of these, 27,709 are adult whites and 14,114 are white children under 16 years of age. The adult colored population numbers 16,356, and the children, 6941. This population lives in 14,400 houses, making an average of 4.5 persons to each house.

The morbidity from pellagra found on examination was approximately 1 to 106 among the whites and 1 to 185 among the colored population; we have no doubt, however, that this approximation of the incidence is lower than the actual. It was impossible to examine all of the inhabitants, particularly males, who were usually at work when the examination was made; a certain number had had pellagra but in the absence of persisting skin changes or because of the unwillingness on the part of patients to give a history no diagnosis could be made; all doubtful cases were excluded; a certain number who had the disease either found it convenient to be away from their homes when it was expected that the examiner would call or refused

examination. This resulted to a certain extent from the fact that the only place available for treatment has so far been at the county isolation hospital, which, because of its inconvenient location and because of the peculiar public attitude toward anything associated with the term "contagious," led to a certain dread of the diagnosis of pellagra, and a consequent evasion wherever possible. This attitude of temporizing extended in a certain degree to some physicians who were quite competent to make a proper diagnosis, but who in frequent instances refrained from doing so, explaining away the symptomatology on a basis which in some instances impeded the recovery of the patient.

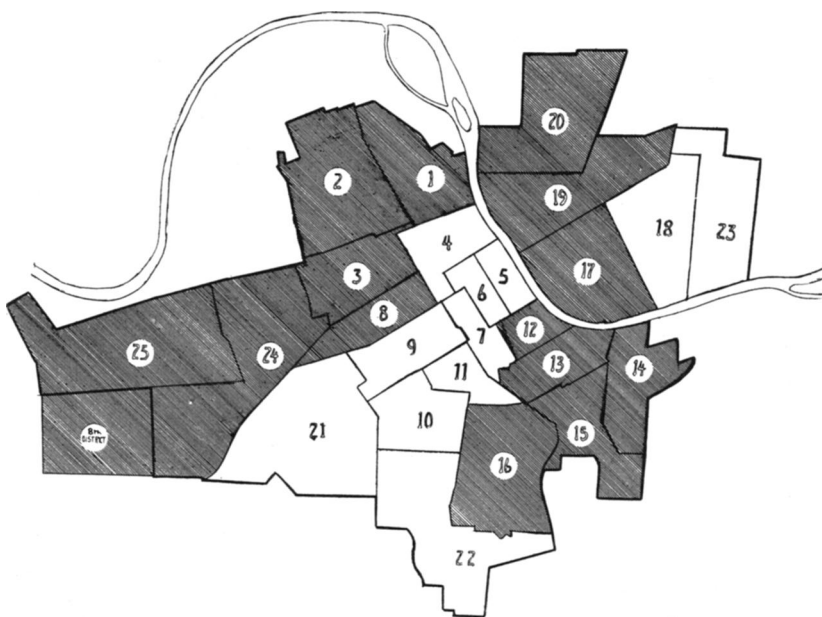


Chart 2. Ward map of the city of Nashville showing the extent of the pellagra survey.

From the survey it has become evident that the origin of pellagra is not uniform throughout the population but is confined to certain areas.

In the outermost tip of the 25th ward in a rather isolated community probably the highest rate is reached, some 10% of the population here having developed pellagra (Charts 7, p. 529, and 11, p. 537).

North Nashville, comprising the 1st and 2nd wards (white) and the 3rd and 8th wards (largely colored) was found to form a center with a high morbidity.

In South Nashville (Wards 12, 13, 14, 15, and 16) pellagra is less evident, except at the outlying parts of these wards, where sewerage is either absent or deficient. Of the patients who have developed the disease in the sewered area very few have failed to give a definite history of frequent contact with cases elsewhere, or of having developed the disease in houses containing other pellagrins.

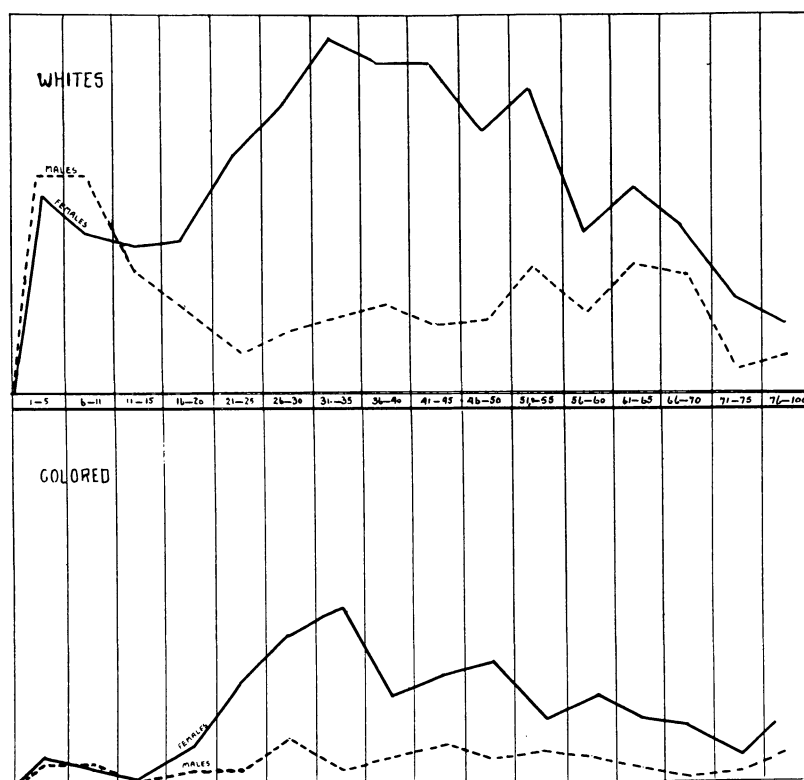


Chart 3. The incidence of pellagra according to sex, age, and color.

In East Nashville (Wards 17, 19, and 20) cases of pellagra were found grouped at the border of the sewered area, few of the cases having originated within that area.

INCIDENCE OF PELLAGRA WITH RESPECT TO AGE, SEX, AND RACE

Those who have investigated the subject, and especially the Thompson-McFadden commission,¹ agree that women are more sus-

¹ First Progress Report of the Thompson-McFadden Pellagra Commission, 1914, p. 29.

ceptible than men, and that children are less so than adults. This is well shown in Chart 3, which gives the ages of 1021 cases. An analysis of this chart shows that of 785 white patients, 249, or 31.7%, were males, and 536, or 68.2%, were females. Of 236 colored people, 52, or 22%, were males, and 184, or 77.9%, were females. Both sexes are apparently equally susceptible up to 15 years of age.

The Thompson-McFadden commission has called attention to the apparent increase in resistance at the time of puberty, which is also brought out in the chart. The greater susceptibility of women is very evident both for white and for colored people after reaching the age of 15, and continues throughout life, tho it is less evident after the age of 55.

An interesting series of cases was that occurring among nursing infants. Twelve pellagrous babies have been observed during the past few years, and of these 5 had pellagrous mothers.

Chart 4, giving the mortality of the series of 1021 cases mentioned, shows that the death rate corresponds very closely with the curve of age incidence shown in Chart 3. The resistance to infection displayed at the time of puberty is shown here by the fact that there was only one death at this age, and that was a colored boy.

TIME OF ONSET

It is well known that pellagra develops more frequently during the warmer seasons of the year and this is shown graphically in Chart 5. An interesting fact brought out in this chart is that negroes do not appear as susceptible as whites during the months when the rays of the sun are not so direct. The figures show that 50% of the white patients developed the disease during the spring months as compared with 30% of the negro patients, while 44% of the white patients developed the disease during the summer months as compared with 66% of the negroes. Of the white patients, 5.8% had their first attack during the autumn and winter months, while 3.2% of the negroes first developed the disease during the autumn, and none during the winter months.

These data are of interest as the theory has been advanced that pellagra is due to photodynamic substances.² If such were the case, we should expect that negroes, because of their dark skin, would not

² Raubitschek: *Wien. klin. Wchnschr.*, 1910, 23, p. 23.

be as susceptible to the rays of light as white people, and that a longer exposure would be required.

By the use of the term "first attack" we mean when the patient first became actually ill, presenting those symptoms which are considered

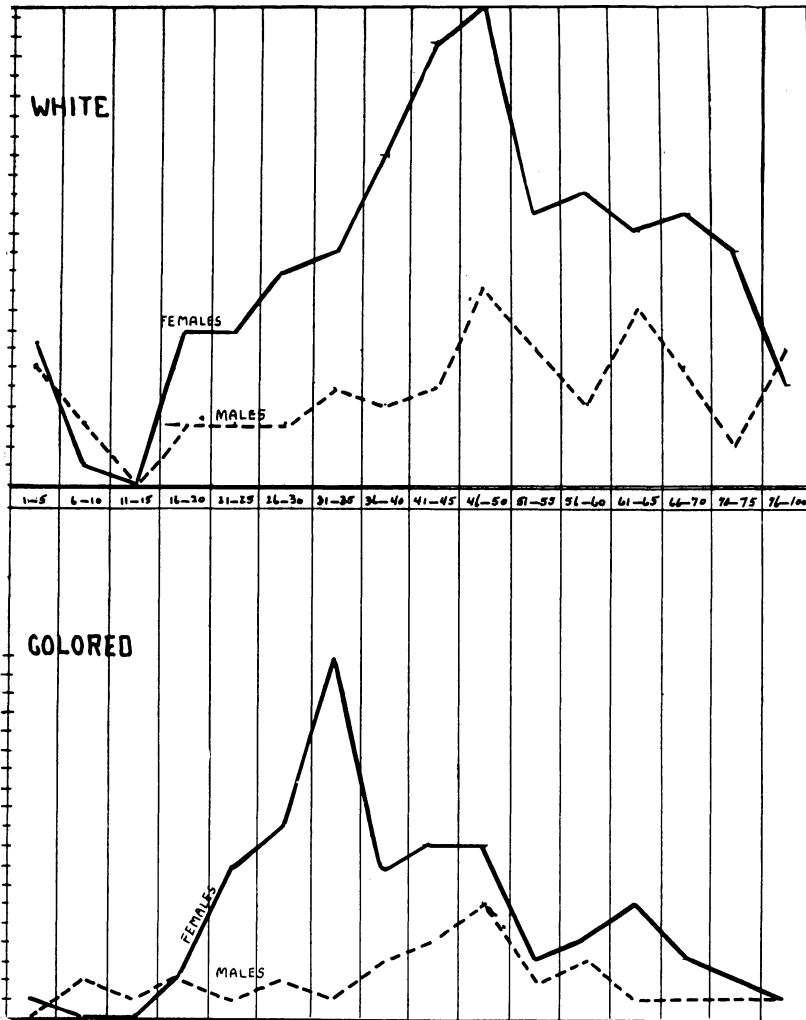


Chart 4. The mortality from pellagra according to sex, age, and color.

as pathognomonic of pellagra. It is probable, however, that the patients had had the disease for some time previous to the acute attack, as the majority stated that they had been suffering for weeks,

and sometimes for months, with nervousness and with symptoms referable to the gastro-intestinal tract.

DURATION OF THE DISEASE

At times neither the patients nor their friends were able to state when the first symptoms of the disease had appeared, and so in Chart 6 the histories of only 493 cases are shown.

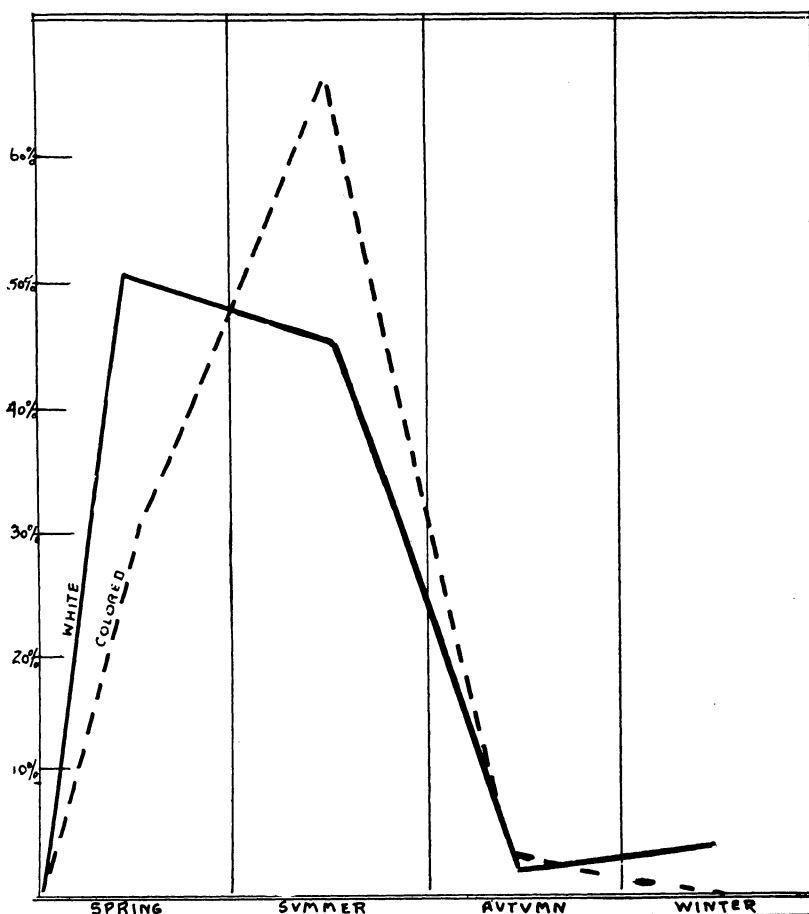


Chart 5. The seasonal onset of pellagra among white people and among colored people.

It will be seen that 234, or 47.6%, of the cases developed during the spring and summer of 1915, and 70, or 14.1%, in 1914. From then back to 1906 the cases became progressively fewer. We have

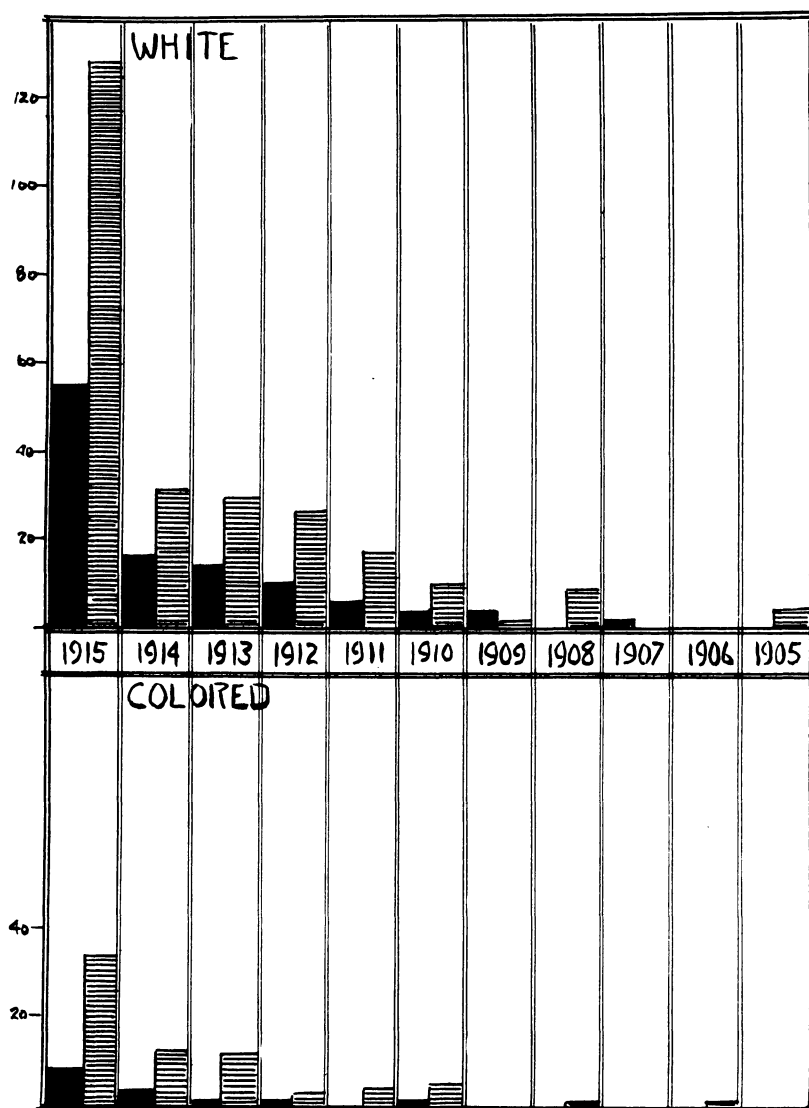


Chart 6. Duration of pellagra.

records of 12 patients, 11 of whom are still alive, who developed the disease previous to 1906, and of one who had her first attack in 1891.

From the data given, one of two conclusions may be drawn: first, that the number of people attacked is becoming much greater, and

second, that the death rate for the past few years has been much higher than our figures indicate. It is probable that both factors are concerned and that the disease is not only more prevalent, but that the death rate has been much higher than is shown in our reports. It must be remembered, however, that these data deal only with those of whom we could get a definite history—493 cases—and not with the entire series. An analysis of the other cases might show a greater prevalence in the years preceding 1915.

The majority of the patients who had had the disease for 5 or more years had not had an attack each succeeding year. Frequently there had not been more than 2 or 3 attacks during the interval, and in one instance, the patient had had a severe attack in 1908 and none after that.

The inquiries devoted to determining the time of onset of each case not only brought out the fact that the disease has possibly been present in this locality since 1891, but they also gave us much added information concerning the relation these cases bore to succeeding ones. In the majority of instances, as will be discussed later, pellagrins were shown to have been closely associated with individuals who subsequently developed the disease.

RELATION OF PELLAGRA TO DIET

Special data could not be obtained for all the 501 cases composing this study, but information which we believe to be reasonably accurate was obtained concerning 421 patients, of whom 320 were white people, and 101 negroes.

The belief that pellagra is due to an improper diet has received much credence, and Goldberger³ and his associates in their experimental studies of several orphanages in the South have shown that a properly balanced diet is an important aid in preventing the annual recurrences of the disease. However, before this can be recognized as the sole etiologic factor causing pellagra, it must be shown that the diet of the people in the localities where the disease has become so prevalent during the last few years has been changed for the worse.

For these reasons inquiries were made of the patients and of their friends as to whether there had been any definite change in

³ Pub. Health Reports, 1915, 30, p. 3117.

the general character of food consumed during the 2 years previous to the onset of the disease, and whether there had been times during this period when they had not had sufficient food. Of the 320 white people, 46, or 14.4%, stated that there had been times during the 2 years preceding their first attack when they had not had sufficient food, and of the 101 colored people, 12, or 11.8%, gave a similar history. This statement of course applies to a deficiency of all constituents and not to a deficiency of any particular one. In only 5 instances were we able to obtain information that there had been a definite change in diet for the worse during the 2 years previous to the onset of the disease. In the remaining instances the patients and their friends asserted that the food consumed had been the same or better in both quality and quantity than they had been accustomed to previously.

Practically all the patients were consuming an excess of carbohydrates. This excessive use of carbohydrates has been discussed already by Goldberger³ and by the Thompson-McFadden pellagra commission.⁴ It appears to be rather general throughout the South. Corn in the form of corn-bread and grits is used extensively, tho corn-bread is not used so much among those who have lived in Nashville for some years as among those living in the rural districts. It is, however, used frequently by the poorer people; bread, in the form of biscuits, made of wheat flour, is also used a great deal. Molasses made from sugar cane enters largely into the diet of the poorer people, tho from statements made it would seem to be consumed chiefly by the children. The last statement does not apply to pellagrins, as a number of patients were living on bread and molasses at the time they were discovered. Investigation, however, revealed the fact that this was not their usual diet, but that it had been adopted because they had a "nervous dyspepsia," which, they believed, was aggravated by meat. In the spring, summer, and autumn months a great deal of green stuff in the form of turnip-tops, wild mustard, green peas, and green onions is eaten. The turnip-tops and wild mustard are cooked with fat meat—sow belly—but the green onions are eaten raw. In addition, much fruit, especially apples and peaches, are eaten during the summer months, as these fruits are usually cheap—from 15 to 20 cents a peck—during this period of the year.

⁴ Siler, Garrison, MacNeal: *Arch. Int. Med.*, 1914, 14, p. 293.

The view that pellagra is due to a deficiency of protein in the diet has received considerable prominence in this country. However, just what constitutes a protein deficiency sufficient to cause the disease has not been stated, and so we must resort to the data supplied by Voit,⁵ Chittenden,⁶ Attwater,⁷ and others, and from this information determine whether the patients had been receiving a sufficient amount of protein to sustain them.

We are not in a position to say just how much protein is necessary for the maintenance of life. Voit⁵ believes that 118 gm. of protein, of which 105 gm. must be digestible, are necessary for an individual weighing from 70 to 75 kilos. Chittenden,⁶ however, with a number of his assistants, several athletes and soldiers, showed that this amount of protein is not necessary; Chittenden kept himself in a condition of nitrogenous equilibrium for months on from 37 to 40 gm. of protein a day. McCay,⁸ in his studies of the metabolism of the Bengalis, of Calcutta, India, found that the natives consumed an average of 40 gm. of protein a day, of which from 2 to 5 gm. were in the form of animal protein. If 40 gm. of protein a day is the average for these natives, it is certain that many must receive still less, and yet we hear no mention of the prevalence of pellagra. McCay sought to determine the influence of low protein intake on the health and economic conditions of the people. He states that they are tall, but that the chest measurements are less than those of Europeans, and that their muscular systems are underdeveloped. He offers this as the explanation of their inability to accomplish as much manual labor as Europeans. He believes that diseases of the kidney occur more frequently among these natives than among Europeans, but makes no mention of pellagra.

It seems that we are justified in assuming not only that a diet containing 40 gm. of protein is sufficient to sustain life, but that, in view of the experiences of Chittenden and his assistants, and the work of McCay, such a diet does not produce pellagra. This then gives us a basis on which to work; in other words, gives us what may be called a limit of safety.

In discussing the amount of protein necessary to sustain life we must not forget the work of Mendel and Osborne.⁹ They have shown

⁵ *Physiologie des Stoffwechsels*, 1881, p. 519.

⁶ *Physiological Economy in Nutrition*, 1904.

⁷ *Principles of Nutrition and Nutritive Value of Food*, 1906.

⁸ *Scientific Memoirs*, New Series Medical and Sanitary Department, India, 1908, 34.

⁹ *Jour. Biol. Chem.*, 1914, 17, p. 325.

that the character of the protein is as important, if not more so, than the quantity, as some proteins are not able to sustain life in experimental animals even when given in excess.

Of the 421 patients included in this series, 282, or 66.8%, gave histories which indicate that they had been getting considerably more than 40 gm. of protein a day. According to races, 66.8% of the white people and 67.3% of the colored people consumed more than this amount of protein daily.

Some of the patients consumed even more than Voit recommends. One family, in particular, shows this fact very well. The family moved from the country to South Nashville and opened a grocery store and butcher shop. Two years later a married daughter who was suffering from pellagra came from the country to live with them; the following spring another daughter and her cousin, who lived in the same house, developed the disease. Careful inquiries concerning the diet of these two children brought out the fact that they had been getting eggs with ham and bread for breakfast, fresh meat for dinner, and all the milk they desired during the day, and besides, according to the father, they would slip into the store and steal bologna sausage, dried meat, candy, etc. In another instance, a colored girl, whose parents owned a grocery store and considerable real estate, developed the disease in spite of the fact that she had been eating fresh meat, milk, and eggs daily. These cases, however, are exceptions, as the diet of the poorer people of Nashville contains an excessive amount of carbohydrates and less protein than that of northern people.

It is possible that the deficiency in protein may be in quality and not in quantity. Mendel says that we should speak of "amino-acid minima instead of protein minimum." This possibility cannot be denied in certain cases, but the diet of the majority of the patients was sufficiently varied to make it improbable. The fresh meat used most commonly among the poorer people is shoulder meat from beef, probably because it is the cheapest. Beans form rather an important part of the diet; ham is eaten by some, and practically all consume a large amount of fat pork meat. In addition, some drink a great deal of butter-milk, which is purchased almost daily, as it is used in the preparation of biscuits and corn-bread. One woman with a well-developed attack of the disease stated that she could not remember a time for years when she had not had at least one glass of butter-milk at each meal.

According to Mendel and Osborne,⁹ it appears that one of the first effects of insufficient protein on young animals is the inhibition of growth. Mendel¹⁰ states that "adequate growth postulates a satisfactory condition of maintenance before any continued gains in

¹⁰ Harvey Lectures, 1914, 15, p. 101.

weight can be made." If this holds true for human beings and if pellagra is due to a deficiency of proteins, or to other dietary faults, we should expect that children who suffer from this disease, and those who live in such families, would show evidence of stunting. On the contrary, no such influence on growth was noted either in the children of families containing pellagrins or in those with pellagra. In size they compared favorably with those in the districts of the city where pellagrins were not found, and not infrequently the disease developed in those who appeared most sturdy.

Another peculiar thing from the standpoint of protein as the causative agent is the fact that men, with the same diet as women, yet with a protein requirement probably greater than that for women, are less susceptible.

RELATION OF PELLAGRA TO SANITATION

Wherever cases of the disease were found, careful inquiries were made concerning the methods of disposal of the excreta, and the source and character of the water used. Trustworthy information was not always to be obtained on these points when the onset of the disease had occurred at some distant place, especially when the patient had been ill for more than a year; hence, we are compelled to rely on the data obtained from a study of 501 cases.

This group of 501 cases was composed of 394 white people and 107 colored. Of the total number, 442, or 88.8%, first had developed the disease while living in houses which were not connected with sewers, and some of the others had presented the first symptoms while living in localities where sewers had only recently been installed. Moreover, some few of the cases which had developed in houses connected with sewers had been either just across the street from, or in houses adjoining, other pellagrous dwellings which had no sewer connections. According to races, 88.2% of the white people and 85.9% of the colored, had developed the disease in houses not connected with sewers.

A classification of the privies used by pellagrins according to the method used by the Rockefeller sanitary commission would be useless here, for while some used the pail system, the benefit which might have accrued from its use was nullified because the pails were almost never protected from flies. In addition, the outside of the pails was almost as filthy as the inside, and from their battered appearance, it

is probable that very few were water-tight. The pails both inside and outside were usually covered with flies. In many instances the excreta of the open-surface privies were disposed of by chickens and hogs. Of the 442 cases, only 20, or 4.6%, were in houses where the privies were properly screened.

The privies are rarely more than 50 feet from the back of the house and frequently not more than from 15 to 20 feet from the kitchen. Not more than 2% of the houses were screened; therefore it will be seen that the flies, which were always very numerous around the privies, could readily pass back and forth from the kitchen to the privy. This is also the probable explanation of the large number of cases of typhoid in the same localities, but this phase of the subject will be discussed more in detail later.

The water used by these patients was obtained from the regular city supply, from wells, cisterns, and springs. The city water supply is obtained from the Cumberland river. The intake is located about 4 miles from the city at a point not far distant from the outlet of Mill Creek, a potential source of pollution at certain stages of river level. The water is treated with aluminum sulfate and sedimentation permitted. It is later treated with calcium hypochlorite. The low bacterial count shows that it compares favorably with that used in other cities.

The cistern water is not as good as might be expected because of the fact that many of the cisterns have cracks in the walls permitting the entrance of surface water, while the majority were not properly covered, and thus acted as breeding places for the mosquitoes, which are present in great numbers. The thin subsoil and the underlying bed of limestone with its cracks and crevices, render the water obtained from shallow wells and springs unfit for use, as no opportunity is presented for filtration. This is particularly true where the wells are only a short distance from the privies.

The same criticisms can be made of the springs, which are probably a greater menace because of the greater number of people using the water. All the water, except that from cisterns, contains considerable lime, and is hard water.

An analysis of 501 cases shows that 55% of the patients used city water, 1.2% spring water, 3% cistern water, and 40% well water. This indicates that the source of the water has but little to do with the development of the disease.

Nashville does offer some very positive evidence in regard to one theory concerning the etiology of pellagra—the theory of Alessandrini.¹¹ According to this hypothesis, the drinking of water containing silicates in certain concentration causes an acidosis which results in the symptom complex of pellagra. Water from limestone sources, on the other hand, is supposed to be remedial. A considerable number of pellagrins in Nashville have always used such water and have developed the disease while drinking it.

RELATION OF PELLAGRA TO PREVIOUS EXPOSURE

In the study of a disease like pellagra, the morbidity and mortality of which are increasing rapidly, we must determine not only the local conditions surrounding each patient, but also the relation which each case bears to preceding ones. In other words, as long as the etiology of the condition is obscure, each and every phase of the subject should be gone into fully, with unbiased mind.

Whenever a case of the disease was found, endeavors were made to find whether there had been other cases in the house or in the immediate neighborhood. Frequently when we were unable to find other cases in the neighborhood, subsequent information obtained from Dr. B. G. Tucker, the county health officer, whose extensive experience with the disease during the past 8 years has made him familiar with most of the cases, showed that the patients had intentionally or unintentionally deceived us, and that they had been in intimate contact with other pellagrins. Moreover, not a few of the patients had been in the habit of paying long visits to friends suffering from the disease. The residences for the preceding 5 years, especially after the development of the disease, were obtained from each patient, and when these had been marked on the map, it was found that a number of the patients who asserted that they had never heard of the disease before, had been living in houses adjoining others which contained pellagrous patients.

That a close relation exists between each case and those preceding it, is shown by the following figures: Of the total number of cases, 169, or 33.7%, developed in houses which contained other cases, while 94, or 18.7%, developed where there were cases in the adjoining houses. Of the remaining patients, 97, or 18.3%, lived in the

¹¹ *Annali d'Igiene*, 1914, 24, p. 1.

same block with other patients with whom they associated, while 35, or 6.9%, visited patients elsewhere, or were associated with them in their daily occupation. Combining these we find that 394, or 78.8%, of the pellagrins, both colored and white, had been associating with other pellagrins.

Of the two sexes, 267, or 78%, of the 342 females, gave histories of having previously associated with other patients, and 128, or 80.5%, of the 159 males, gave similar histories. From this it will be seen that the two sexes had been equally exposed, but it must be borne in mind that the males constituted only 31.7%, or one-third, of the 501 cases composing this series.

The significance of these figures will be better realized when one stops to consider the difficulty encountered in obtaining contact histories with such a disease as typhoid fever.

A marked difference was found between the number of contact histories obtained of white people and the number obtained of colored people, the figure for the white people being 84.5%, and that for the colored 57.9%. This is probably due to the difficulty encountered in getting good histories from the colored people because of their failure to remember dates and addresses. Both classes among the poorer people move frequently, but while the white people can usually give the exact addresses of their previous residences, the negroes can rarely do so.

RELATION OF PELLAGRA TO THE DENSITY OF POPULATION

The origin of pellagra in Nashville bears no relation to the density of population either of whites or of colored people.

If pellagra is transmissible and due to a constant contact, we might assume that the opportunity for such contact would be much greater in the area of greatest density of population. This factor is nullified to some extent, however, by the fact that in the districts where the population is not so dense, the house to house association due to constant visiting with neighbors—which becomes apparent in survey work of this kind—may be much more intimate than in the tenement districts where two- and three-storied houses enable more people to live in a small area.

The relation is further complicated in that the conditions as regards sanitation are not comparable, because the area of greatest density

is practically wholly sewered. Economically, at least as far as the surveyed area is concerned, there is no great difference between the population in the area of greater density and that in the area of less density.

The approximate ratio is illustrated in Chart 7, in which relative density of the separate wards is expressed in various degrees of shading. The relation of density of population to the morbidity from pellagra is also shown in Chart 7.

RELATION OF THE DISEASE TO SOCIAL AND ECONOMIC CONDITIONS

A study of the epidemiology of pellagra in a community would be incomplete without an investigation of the economic conditions. For this reason, we tried to obtain information concerning the wages received and the general cost of living for the past 5 years in Nashville. On this subject, however, we were unable to obtain accurate information; therefore, the statements which follow must be more or less general in character.

The wages received today by the class of people among whom pellagra is most prevalent are somewhat higher than those received 5 years ago. Work was readily obtained until the early autumn months of 1914, when as a result of the financial crisis incident to the European war, some factories were closed, others were run only part of the time, and the average wage of the laborer was therefore reduced. This condition resulted in a slight increase in the number of people making application for assistance to the charitable institutions during the winter of 1914-1915. In the spring of 1915 work became more plentiful and by September the factories were all running full time.

House rents in the surveyed areas have not increased during the past 5 years. This holds true for those having vault and surface privies, as well as for those having the alley sewer connections.

Food, especially meat, has increased in price during the past 10 years, but the increase has been comparatively little during the past 5 years. In 1913 vegetables were also high owing to a failure of the crops, but in 1914 and 1915 they were plentiful and cheap. During the summer of 1915, when pellagra was more prevalent than ever before, vegetables were very cheap.

It appears then that there was a period of economic depression beginning about September, 1914, and lasting into the early summer of 1915. This depression was made evident by the increase in the number of applicants for assistance at the charitable institutions. This depression was partly neutralized by the cheapness of certain foods. The first great increase in the number of cases of pellagra, however, occurred in the spring and summer of 1914, before the outbreak of the war; therefore, the increase cannot be ascribed to this cause.

In discussing the influence of periods of economic depression we should not forget the years 1893, 1903, and 1907, when conditions in Nashville were at their worst, and yet no pellagra was reported.

THE MORTALITY FROM PELLAGRA

During the years from 1910 to 1915 there occurred in Nashville about 100 deaths in which a diagnosis of pellagra was recorded

Chart 7. The relative density in population of the various wards and the origin of 600 cases of pellagra therein.



on the death certificate or entered as the chief or as a contributory cause of death. These are distributed as follows:

1910.....	8
1911.....	12
1912.....	6
1913.....	16
1914.....	20
1915.....	37
	<hr/>
	99

This, however, does not include the patients from Nashville who died at the isolation hospital. When these are added the figures are as follows:

1910.....	8
1911.....	16
1912.....	14
1913.....	23
1914.....	24
1915.....	62
	<hr/>
	147

Apart from these recognized cases, numerous deaths occurred from pellagra in which the proper cause of death was not stated on the death certificate. These were ascertained as follows: The individual morbidity records were compared with the death records, and when it was found that a case had been reported by some physician as pellagrous with a later fatal termination, the symptomatic diagnosis usually recorded was disregarded and the death considered as due to pellagra; certain of the cases had been seen by the county health officer and by the city health officer, and, tho the death certificates did not properly record the cause of death, it was regarded as a death from pellagra; in a few instances, probably less than a dozen, a clear history was obtained from relatives. During the year 1915, of course, a considerable number of cases seen by our examiners terminated fatally. In such instances, if the death certificate did not record the death as due to pellagra, we made the proper notation on our records.

With these additional records the mortality rate was corrected and for the 6 years is approximately as follows:

1910.....	28
1911.....	54
1912.....	40
1913.....	47
1914.....	55
1915.....	108
	<hr/>
	332

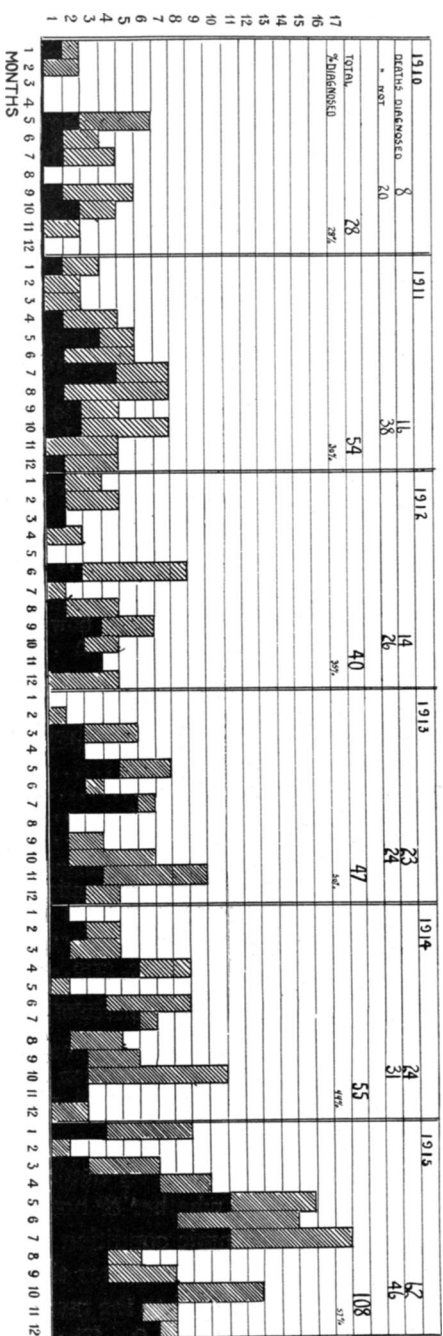


Chart 8. The black columns indicate the number of cases resulting fatally each month (1910-1915) that were diagnosed as pellagra; the shaded columns, those which were not so diagnosed.

About 46 other cases are known to have terminated fatally, some of them prior to 1910; the greater number of them originated in Nashville, but because it was impossible to trace the death records of some of these, they have not been entered in the tabulated list.

Of the total number, 262 were white and 116 colored. Of the 262 whites, 77 were males and 185 females. Of the 116 colored, 31 were males and 85 females. The ages at the time of death are shown in Chart 4 on p. 517.

Of the 332 cases that have resulted fatally since 1909 it will be recalled that a considerable number were diagnosed. The proportion is brought out in Chart 8, in which the black columns indicate the number of cases resulting in death each month which were diagnosed as due to pellagra, and the shaded columns the cases which were not so diagnosed. It will be observed that the percentage of cases diagnosed has increased progressively, so that at present only about 40% of the total number are not properly recorded on the death certificate.

Among the causes of death which were assigned on the various death certificates, it might be of interest and of some value to enumerate the following:

	{ Dysentery, flux, diarrhea.....	41
	{ Tuberculosis of bowels.....	17
	{ Tabes mesenterica	
Gastro-intestinal.....	{ Iliocolitis	15
	{ Gastritis-gastric catarrh	15
	{ Cancer of stomach.....	6
	{ Cirrhosis of the liver.....	3
	{ Noma	
Oral.....	{ Ptyalism	
	{ Cancrum oris	8
	{ Stomatitis	
	{ Neurasthenia, melancholia	
Nervous.....	{ Menopause, dementia	29
	{ Insanity, meningitis	
	{ Suicide	5
	{ Heart disease, grip.....	13
	{ Typhoid, senility	
	{ Nephritis, tuberculosis	

Occasionally several of the more or less symptomatic diagnoses were found entered, apparently because there was some question in the mind of the physician. At other times skin lesions were also added, such as "tetter," "eczema," "erysipelas," etc.

The death rate for 1915 approximately doubled that of the previous year. It is difficult to determine whether or not this increase had some relation to the unfavorable economic condition which prevailed during 1914. Such a relation is at any rate a factor that must be considered.

The relation of the total mortality to the mean monthly temperature for the 6 years is illustrated in Chart 9. The curve shows 2 periods

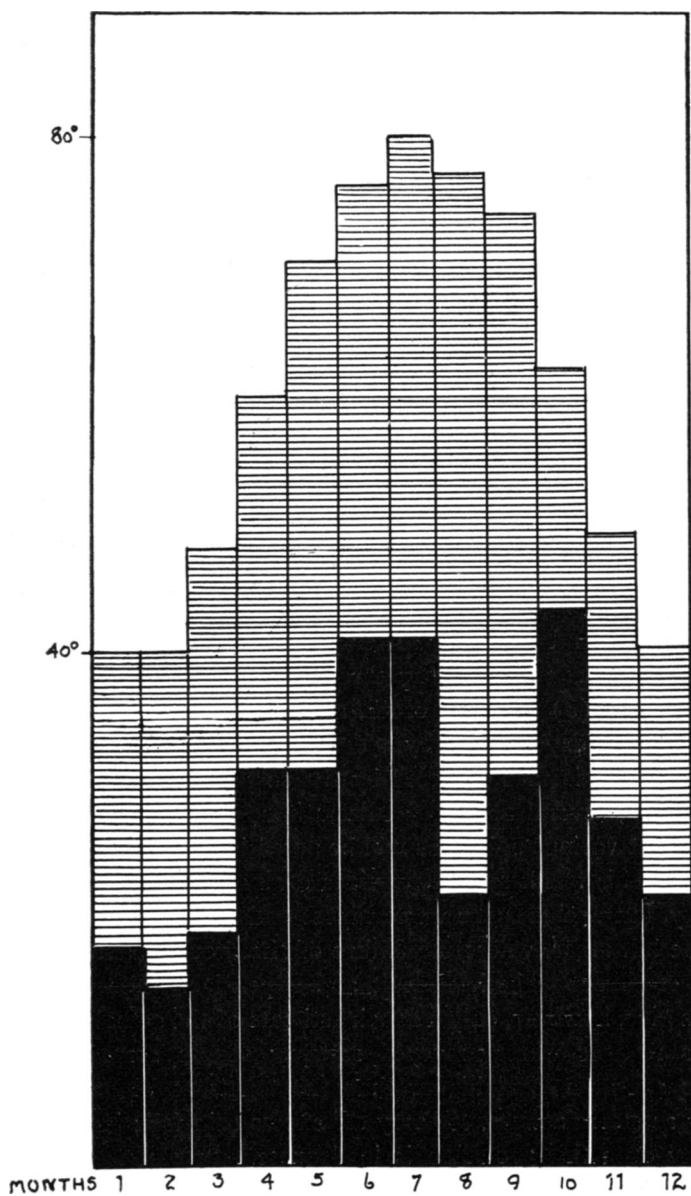


Chart 9. The relation of the mortality from pellagra to the mean monthly temperature for a period of 6 years.

of increased mortality, one during June and July, the other during October. It seems that the first period of prolonged high temperature kills off the most debilitated cases carried over from preceding years; then, with the exhaustion of this material, the mortality is decreased until such time as the more severe cases which have originated during the same year have commenced to succumb, usually late in the summer.

THE RELATION OF PELLAGRA AND TYPHOID TO THE SYSTEM OF SEWAGE-DISPOSAL

In the preceding discussion it has been shown that fully 88% of the cases of pellagra which have originated in Nashville have originated in houses without facilities for sewage-disposal other than open privies. A very evident relation might therefore be presumed to exist in this connection.

In order to obtain a more comprehensive idea of the conditions responsible for the present status of the sewage plant it is necessary to refer to the topographical map (Chart 10).

In the part of the city lying west of the river 3 drainage areas are established: (1) Lick Branch, draining through the so-called Sulphur Dell and providing sewerage for the greater part of the city; (2) Wilson Branch, draining through the lowland known as Black Bottom; and (3) Brown's creek, an open sewer to which the entire southwest drainage of the city is diverted. In East Nashville the chief drainage area is that occupied by the so-called Edgefield sewer (4). In addition, several accessory sewers have been constructed, entering the river at various points, as will be noted in the diagram of the trunk sewers. This trunk system provides drainage for the greater part of the city, but excludes the westernmost and northern parts of the city, and the hill areas, where the nature of the ground (limestone) makes sewer construction both difficult and expensive. The existing trunk sewers give, however, only a rough estimate of the actual area provided for as regards water-conveyed sewage; for in some instances the sewers are at a level higher than the toilets to be flushed, serving purely as storm sewers, to carry off excess rain-fall; in some parts of the city even this provision is inadequate. In the poorer section of the city when sewerage is provided, the conditions are by no means ideal, for the toilets using so-called alley sewers, are out of doors and in the majority of instances in an exceedingly filthy condition.

Chart 10. Topographical map of Nashville, showing the existing system of trunk sewers.



The value of the trunk sewer is impaired because the essential lateral sewers have not been completely constructed. In a part of South Nashville (13th and 14th wards) this condition was only remedied during very recent years and the area still suffers from a rather high typhoid morbidity. On the other hand, in some instances sewerage has been provided for some blocks, while water connections are lacking. During the last year some blocks have been sewered in North Nashville, which until the present year furnished large numbers of pellagrins. The actual sewered area is shown in Charts 11, 12, and 13, in which the shaded area represents the part of the city in which sewerage connections are possible.

When we now consider the sewered area, it is found that as regards the relation of pellagra to the disposal of water-conveyed sewage 4 groups of wards can be studied (see Charts 2, p. 514, and 11, p. 537).

Group I (North Nashville), containing the 1st, 2nd, 3rd, and 8th wards, is largely unsewered.

Group II (West Nashville), containing the 24th and 25th wards, is wholly unsewered.

Group III (South Nashville), containing the 12th, 13th, 14th, 15th, and 16th wards, is, with the exception of the 15th ward, now fairly well provided with sewers.

Group IV, containing the 17th, 19th, and 20th wards, is also fairly well sewered, the areas indicated as not yet sewered, being largely factory sites.

We can therefore roughly divide the sewered areas into 2 sections, a poorly sewered area (Groups I and II) and a fairly well-sewered area (Groups III and IV).

In the 1st section, lives 46% of the total surveyed population; in the 2nd section, 54%.

In the 1st section, 10,100 negroes live, in the 2nd, 12,100, the approximately equal population indicating approximately equal economic standards in the two divisions. It should be emphasized that, apart from the evidence afforded by the apparently equal distribution of the negroes, the two divisions are representative of equal economic and social conditions in other respects.

In these areas approximately 600 cases of pellagra are known to have originated (about 375 during the past 2 years) and about 435 cases of typhoid have originated in this area during the past 2 years.

The percentage of known cases of pellagra originating in these divisions, the percentage of cases originating during the past 2 years,

Chart II. Relation of the mortality from pellagra to the unsewered areas. The shaded portion indicates the part of the city in which sewerage connections are possible.



the percentage of deaths from pellagra, and the percentage of morbidity from typhoid are shown in Table 1.

An analysis of the table reveals the following facts: In the 1st division (inadequate sewerage) with 46% of the population, originated 63% of all cases of pellagra, and of the cases developing during the past 2 years, 69%. The corresponding figures from the 2nd division (fairly well sewered) are 35 and 31% respectively.

These figures, apart from their direct bearing, would also indicate that in the area with the poor sewerage the tendency is toward an increase in the number of cases. Whereas in the 2nd division, which has had considerable improvement in sewerage during the past 5 years, pellagra is decreasing at present. It is to be emphasized, however, that even in this 2nd division surveyed, in which the sewerage is fairly adequate, the majority of cases of pellagra originating occurred in houses which were without sewerage connections.

TABLE 1
RELATION OF PELLAGRA AND TYPHOID TO THE SYSTEM OF SEWAGE-DISPOSAL

Sewer System	Percentage of Total Pellagra	Percentage of Pellagra 1914-15	Percentage of Deaths from Pellagra	Percentage of Typhoid Morbidity
Inadequate..... {Group I (Wards 1, 2, 3, 8) Population 21,909 (34%) }	36	40	35	43
None..... {Group II (Wards 24, 25) Population 7885 (12%) }	27	29	16	13
46% of population.....	63	69	51	56
Almost complete {Group III (Wards 12, 13, 14, 15, 16) Population (31%) }	23	20	28	26
{Group IV (Wards 19, 20) Population 14,779 (28%) }	12	11	20	18
54% of population.....	35	31	48	44

When we now study the distribution of deaths (about 200), it will be observed that the disparity noted in the relation to the origin of the disease does not hold true, the figures—51% and 48% respectively—are much nearer the ratio of the corresponding population.

The typhoid morbidity, as might be expected, is greatest in the 1st division—being 56% as compared with 44% in the 2nd.

Whenever the apparent relation of the origin of pellagra to poverty is discussed, the argument is usually advanced that the poorer



Chart 12. The relation of the mortality from pellagra (1908-1916) to the method of sewage disposal. The shaded portion represents the part of the city in which sewerage connections are possible.

classes live in the unsewered parts of the city while those economically more fortunate live in the sewered portion, and this in general holds true. In Nashville, however, this condition is to a certain extent (at least in the surveyed area) reversed, inasmuch as a large part of the older portion of the city, now completely sewered, is occupied by an industrial white population and a large negro element (South Nashville), whereas some of the unsewered and newer parts of the city contain in places a very substantial class of white people. From the point of view of the relation of pellagra to sewage-disposal and poverty the situation is therefore of considerable interest in a study of this kind.

If pellagra is due to a dietary deficiency essential to poverty, we should expect that the deaths from pellagra would predominate in the unsewered area, that is, would bear the same relation to the unsewered areas as the origin of pellagra, because, according to this idea, people in the so-called "pellagra class" would not be economically so situated that they could live in the sewered areas.

As a matter of fact, the death rate, as will be observed from the table, is very nearly equal in the two areas under consideration, indicating in a striking manner that the poorer classes are not only equally distributed in the two areas but that many patients who had developed pellagra elsewhere had come to live and die in the so-called better districts.

In the consideration of the equal distribution of deaths from pellagra and the equal distribution of the colored population in the areas under consideration, it becomes apparent that the economic conditions on the whole are also comparable. Hence, the very apparent difference in the numbers of cases of pellagra which have originated in these areas must bear a distinct relation to the method of sewage-disposal, which is, as far as we are able to determine, the only factor of difference in the environment of the people living in the areas under consideration.

The relation of the origin of typhoid fever to the method of sewage-disposal is illustrated in Chart 13. During 1915, 416 cases of typhoid were reported to the city health office, probably the highest morbidity for any of the larger cities in the country.

DETAILED STUDY OF THE EPIDEMIOLOGY OF PELLAGRA

In a discussion of the relation of a constant contact to the development of pellagra in Nashville the fact was brought out that in the case of practically 78.7% of the patients even a cursory history had

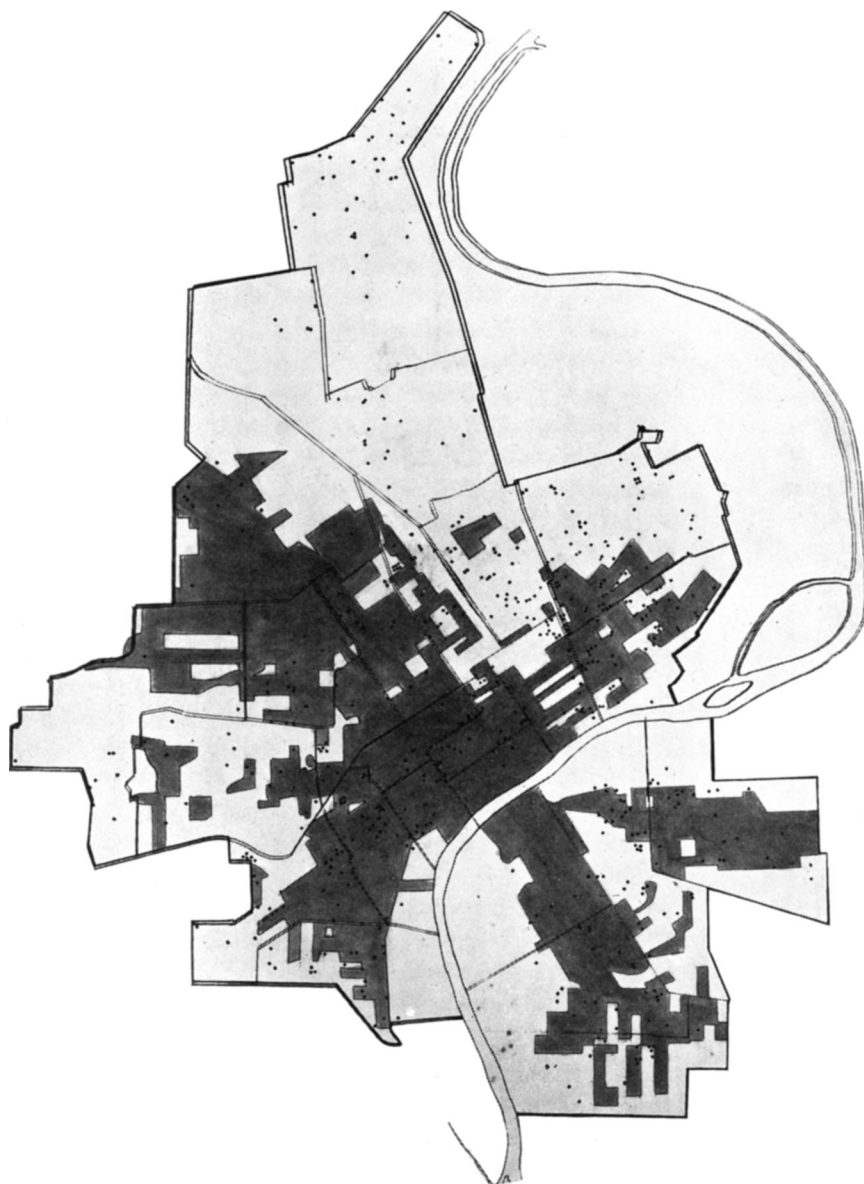


Chart 13. The relation of the morbidity from typhoid fever (1914-1915) to the method of sewage disposal. The shaded portion represents the sewered area.

revealed evidence of an association between the development of the disease and contact with previous cases. We are fully aware that in a population having a pellagra morbidity of approximately 1%, an intimate and constant contact is bound to occur among pellagrous individuals due to purely fortuitous circumstances, not the least among these being the result of a frequent change of residence from one house to another; and there is also the undoubted fact that, on the whole, pellagra is a disease of those economically less fortunate, who, by reason of circumstances, live together in more or less intimate contact. We nevertheless have been so impressed by the evidence that new cases develop only in those individuals who somewhere and at some time have either lived near or have associated intimately with pellagrins, that we think it might be of interest to record in graphic form some of the examples that came under observation, the more so since, with the exception of the work of the Thompson-McFadden commission, no detailed epidemiologic studies concerning pellagra have been published in this country.

We do so fully cognizant of the undoubted value and importance of the work accomplished, which places the etiologic basis of the disease in purely metabolic disturbances due to the imperfect dietetic condition of a great mass of people. We believe nevertheless that thus far the experiments designed to elucidate this point are inconclusive and by no means final, that considerable work remains to be done both in epidemiologic studies and animal experimentation, and that for the present at least the question of etiology is still an open one.

That pellagra is a disease of certain localities, a disease of "place," has been frequently observed in Europe and in this country, and the situation in Nashville does not differ in this respect from that observed elsewhere. This grouping in certain well-defined areas in wider districts has led in theory to the correlation of the topography and the geology of the country with the distribution of the disease, giving rise, among others, to the hypothesis that pellagra is prevalent only in those regions in which lime salts are deficient in the water and silicates too abundant. The Italians have emphasized also the fact that even in the larger pellagra districts, more cases and more severe cases will originate in certain villages or districts than in others, despite otherwise comparable economic and hygienic conditions.

The study of the origin and distribution of the disease in Nashville revealed numerous instances of this situation; almost all cases could

be traced in their origin to some rather well-defined focal area, some of the smaller of which will be described in the following charts.

Chart 14 represents a rather isolated community of white people living in the tip of the 25th ward, an area which contains almost 40 squares. It is surrounded by factories—fertilizer and woodworking factories—and vacant low-lying areas. A railroad branch line forms a partial boundary, dividing the district into 2 parts. The houses are of frame construction, containing 3 or 4 rooms, and are usually separated by a space of 25 or 30 feet. There is no sewerage or city water supply; open and exceedingly unsanitary privies are intermingled with shallow wells. The families frequently move, often to or from North Nashville.

In the area west of the railroad live some 550 people (309 adults, 248 children); the community life centers to some extent about a small park containing several springs, and about a free clinic established by several of the charitable organizations. In this area pellagra has been evident for at least 7 years, some of the earlier patients dating their first symptoms to the spring of 1908 when living in houses along Street C. Inasmuch as no definite addresses could be obtained from these cases they have not been charted, but it will be observed that other cases originated in 1910-11 and in 1912 in the adjoining houses. The greatest number of cases, however, have originated in very recent years, and will be described in detail.

House 1.—A white woman 50 years of age. Stated that she had first had an eruption in 1911, with recrudescence every year following. Address when first attacked not obtained.

House 2.—A white woman, aged 20 years. When the history was obtained, the patient was living in East Nashville, having moved there from House 17. From 1913 to the spring of 1915 she had lived with her father and mother in House 17; her father had pellagra. The eruption had begun in the summer of 1915.

House 3.—A white woman, aged 27 years, who had first had an eruption in 1912 while living in House 42. Her mother and sister-in-law had developed the disease in 1911 or 1912 while living with her in House 42.

House 4.—Two patients had lived here in the spring of 1915. The older, a white woman of 42, had had the disease for several years. While living here the son, aged 20, had developed the disease and after he had moved to House 62 a third case had developed in a daughter, aged 13. Recently another family had moved in. This was the son of the patient in House 35, and brother of the patient in House 7. His 2 children had developed pellagra in 1915 after living in the house.

House 5.—Two cases, both in boys, aged 12 and 13. Had begun in 1915.

House 6.—A woman of 52, living here 7 years, had had pellagra since 1912. In 1913 a woman and her child had come to live with her and both had developed pellagra.

House 7.—A woman of 23 and her 3 children had developed pellagra here in 1915. She was the daughter of an old man living in House 35 who had had pellagra several years. In this house a 15-year-old girl had died in 1911 from pellagra.

House 8.—During the winter of 1914 a woman and her child had lived here who had pellagra; they now lived in House 45. In the family that afterward had moved into House 8 a child had developed pellagra in the summer of 1915. This child formerly had lived at House 9.

House 9.—In this house one patient had been living and another had developed the disease early in the spring of 1914; the occupant at the time of the survey was a woman of about 30, who had had pellagra for several years and had had a typical eruption for at least 5 years. She had moved from House 23 during 1915. Her sister, a woman of 25, living in House 49, had pellagra, and had lived with her at various times. In the spring of 1915 the son, aged 14, had developed pellagra while living here in House 9.

House 10.—A white woman of 48, who had had a typical eruption for several years. She also had diabetes. Her daughter, aged 10, had had a mild eruption in the spring of 1915.

House 11.—A boy of 16, who had had his first eruption when living in House 40, four years before. His aunt and her child, living elsewhere in the city, had died in 1914 from pellagra.

House 12.—A boy in this house, aged 13, had developed pellagra during 1915.

House 13.—A woman of 77 had died here in 1911 from pellagra. No history to be obtained. Two years later a son, aged 44, who had had pellagra for some time, had committed suicide here.

House 14.—A woman of unknown age had died here in 1913 from pellagra; no history to be obtained.

House 15.—A woman of 48 had developed the disease here in 1912. She was living in House 19.

House 16.—In 1912 a white man of 63 years had died in this house from pellagra; no history to be obtained.

House 17.—In this house an old patient had lived for some time, and the daughter had developed pellagra here early in 1915. At the time the history was obtained, the daughter was living at House 2.

House 18.—Two patients had lived here for a short time in 1914; were living in House 24 at the time of the survey.

House 19.—The residence of the pellagrin whose case had originated in House 15.

House 20.—Four cases had developed here in the spring of 1915; these were in 4 girls about 6, 8, 11, and 14 respectively. The family had associated constantly with the family in House 17 during 1914.

House 21.—A white woman of 37, who had had pellagra since 1912, when she lived next door to a case (See Chart 16, House 3).

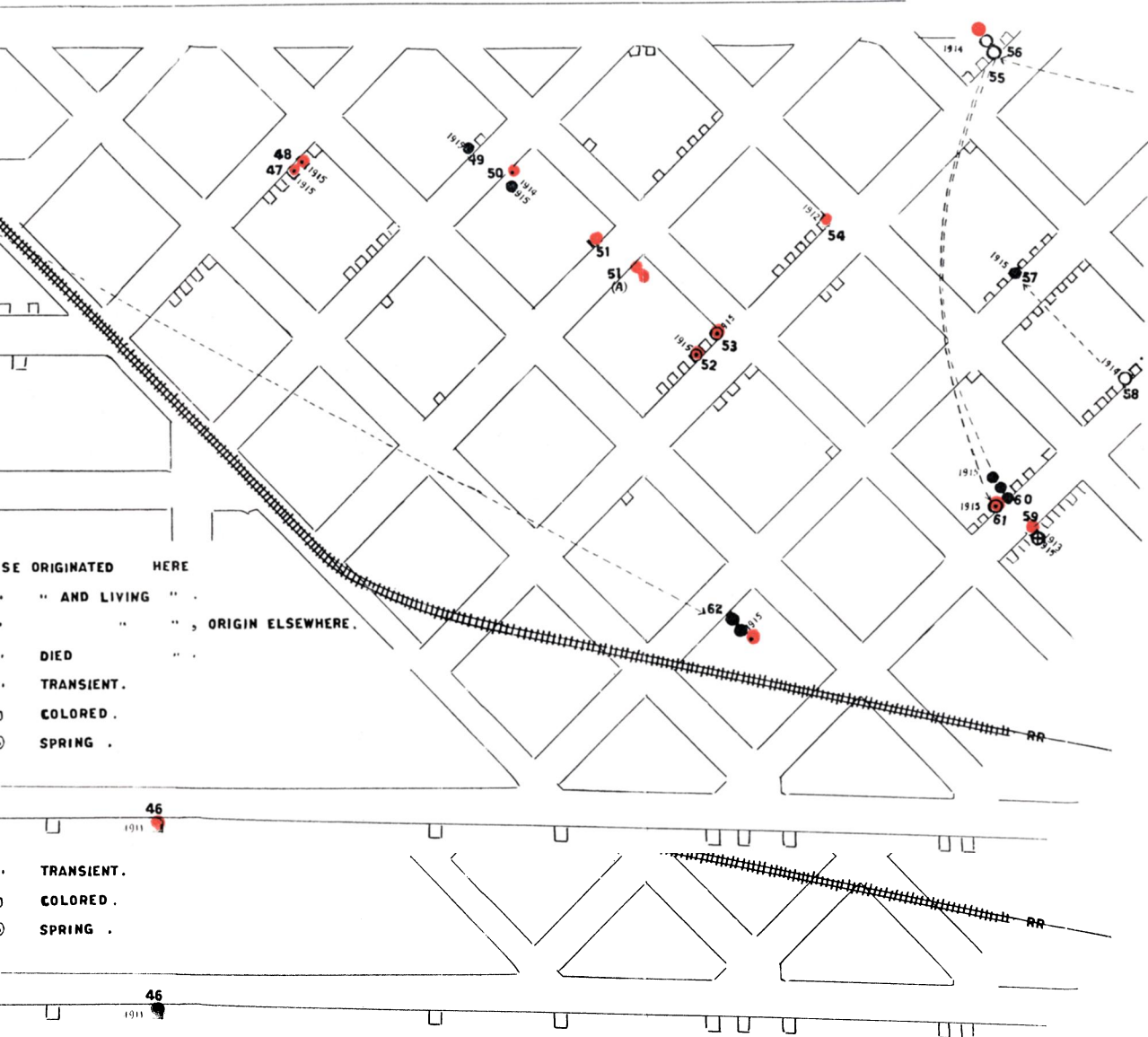
House 22.—A woman of 43, whose illness had begun 5 years before, when living in House 44. In the spring of 1915 she had had an eruption for the second time. In the following summer her son, aged 17, had had an eruption for the first time.

House 23.—The pellagrin living in House 19 had lived here from 1911 to 1914. The present family had moved in in the spring of 1914, and a case had developed in a girl of 16 years of age.

House 24.—In this house there had been 3 patients of which 2 had recently died. This family had lived for a time in House 26, had then moved to House 9, where another case had developed; then to House 18, and from the spring



Chart 14. The sequence of cases of pellagra in a part of the 25th Ward. Th



part of the 25th Ward. This color key is to be used also for following charts.

of 1915 had lived in House 24. One of the children had died from pellagra here; another had died from tuberculosis but had had a pellagrous eruption in 1914 when living in House 9. Another case, which had originated in House 38 in 1912, was living with this family.

House 25.—A boy of 15, who had had an eruption for the first time in 1914 when living in House 51. He now lived with his grandmother. His youngest sister, aged 3, had recently died from pellagra in House 34.

House 26.—In 1912 a white woman of 56 had died here from pellagra; in 1914 another pellagrous woman had moved in who later had moved to Houses 8 and 45.

House 27.—A white woman of 68, who had developed pellagra during 1915.

House 28.—A man of 57. Had developed pellagra in 1915. This patient had lived in different houses. No history obtained.

House 29.—A woman of 45. Had had pellagra for several years; had formerly lived in South Nashville. Her son, aged 15, had developed a typical eruption in the summer of 1915.

House 30.—An old case of at least 7 years' standing, which had begun in Rutherford county. The woman was 45 years old.

House 31.—Two children, aged 5 and 6 respectively, had developed pellagra when living in this house in 1914; had later moved to Houses 39 and 41.

House 32.—At the same time one case had developed in this adjacent house—this was in a boy of 6. During the summer of 1915, 2 more children in the family had developed typical lesions (aged 9 and 4).

House 33.—A patient living here had developed pellagra in 1912 when living in House 10. Her son, aged 13, had developed pellagra during the spring of 1915.

House 34.—In this house a child of 3 recently had died from pellagra. (A sister was living in House 25.) The history of the family was as follows: Originally had lived in a house not shown on the chart, had moved to House 51, and then the mother had died (from tuberculosis) and the boy who had developed pellagra had moved to the house of his grandmother (House 25). The rest of the family had come to House 36, where they had been joined by an old couple from the country. The old man was a pellagrin. The father of the child had recently developed suspicious symptoms—ptyalism, diarrhea, etc.

House 35.—A man of 66, who had had pellagra for 5 years. It had begun in Hickman county. His daughter and their family lived in House 7; his son in House 4; both families had pellagra.

House 37.—A boy of 13. Symptoms had begun during the summer of 1915.

House 38.—A case had developed here in 1912, and was now in House 24.

House 40.—A case had developed here in 1911; was now in House 11.

House 41.—The patient living here had developed the disease in 1914 in House 31.

House 42.—Three persons had developed pellagra in this house in 1911 and 1912—a woman of 40; her daughter, 19 years old; and her daughter-in-law, 25 years old. The latter now lived in House 3. An infant had died here in 1913 from pellagra.

House 43.—In 1906 a child of 6 years had developed pellagra in the adjoining house. This family now lived elsewhere.

House 44.—The patient who was living in House 22, had developed pellagra here in 1910.

House 45.—A woman of 45 had developed pellagra here 7 or 8 years before when living in North Nashville. This patient in 1914 had lived for a time in House 26, had then moved to House 48. While there, the youngest baby, 18 months old, had developed pellagra. She had then moved to this house and

here her daughter of 12 years, had developed typical symptoms during the summer of 1915.

House 46.—A man of 45 had developed pellagra here in 1911; later had died elsewhere.

House 47.—Girl of 11, living here 3 years, had developed pellagra during the summer of 1915.

House 48.—Boy of 10, living here 5 years, had developed pellagra during the summer of 1915.

House 49.—Woman of 25. The disease had begun 7 years before as a "tetter" on both arms. She had been well for a time but in the summer of 1915 again had had a complete symptom complex. This patient was the sister of a pellagrin in House 9, and had lived with her at various times.

House 50.—In 1914 a case had developed in this house—in a boy of 16. The mother, 45 years of age, had had pellagra for several years, the disease probably having begun in the country. In the house immediately behind 51, had lived a family in 1913 in which one case had originated in 1913, which was now in House 25. In House 51-A, 2 cases had originated during 1914, one in a woman 44 years old, the other in her son, aged 13.

House 52.—A case had developed here in the summer of 1915 in a man of 67. He had been living here for 26 years.

House 53.—At about the same time another case in a woman 80 years old, had developed here, the second door from the previous house.

House 54.—About 3 years before, a woman of 38 had developed pellagra here. Had lived here 7 years before.

Houses 55 and 56.—In House 56, 2 patients had lived during 1914, a woman of 54 and her daughter of 30. The 11-year-old son of the latter woman had developed the disease while in this house. The family then had moved to House 60. In the adjoining house (35) had lived a family who later had moved to House 61. A boy in this family (aged 16) had developed pellagra during 1915.

House 57.—Here there was a woman 45 years of age who had had a typical skin lesion in 1915, and had had a sore mouth for 2 or 3 years. In 1914 she had lived in House 58, and had always lived in the neighborhood.

House 59.—A patient had died here during 1915—a woman 41 years of age, who had suffered from a diarrhea for many years and had had a typical skin lesion for 2 years. Had always lived in this house.

House 60.—The family here had been in House 4 in 1915. One case had originated after the family had moved here.

In a general survey it will be noticed that none of the cases originated, as far as we know, on Street A, despite the fact that economically the people living here are in the same class as the others in the district. They are separated, however, by a rather wide vacant area in the rear of the houses.

The majority of the cases occurred in Street B and the next lower street, and the earliest recorded deaths occurred along these streets (3 in 1911, 1 in 1912, 2 in 1913, 1 in 1915). An old area seems also to have been that along Street C.

Chart 15 illustrates the sequence of cases in a small area in East Nashville. The shaded portion represents the sewered portion. The same color key as in Chart 14 is used in this and following charts.

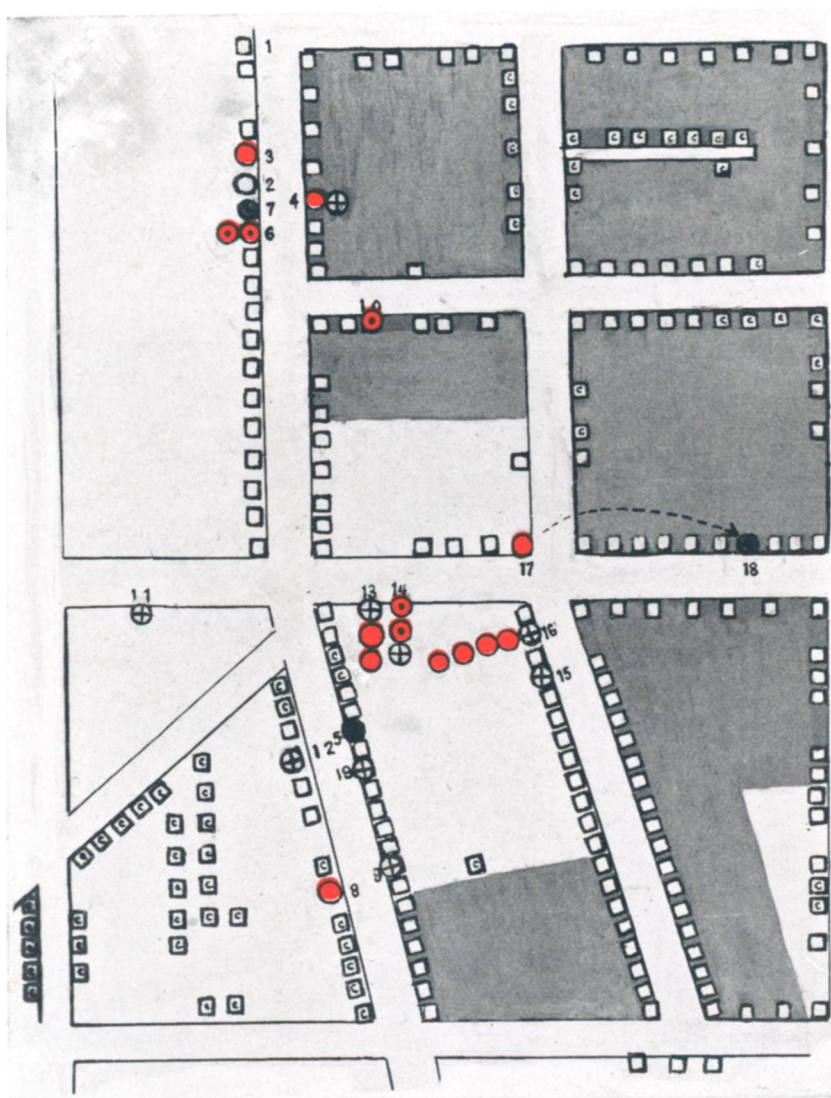


Chart 15. The sequence of cases of pellagra in a small area in East Nashville. Same color key used here as in Chart 14.

House 1.—A patient had died here in 1910—a white man of 25 years—the chief symptoms being diarrhea. No further history was to be obtained.

House 2.—A white woman of 54, now living elsewhere, had lived here during part of the year 1914. She had had all the symptoms of pellagra in 1911, but had since made a complete recovery.

House 3.—A case had developed here in 1914 in a white woman of 33. This patient had come from Sparta, Tenn., about Jan. 1, 1914, had lived here 8 months, and then had moved to another address. She stated that her hands had got "dry" during 1914. At the time that the history was taken she had all the symptoms of pellagra. It is not definitely known whether she had had pellagra before coming here.

House 4.—In the spring of 1915 a patient had lived here. This was a 3-year-old girl, who in the winter of 1914, had lived at the edge of town. This case had developed in House 4, and the patient was now living in House 5. In 1911 a colored woman, aged 33, had died in this house from pellagra. The death certificate stated that death had been due to erysipelas of 4 months' duration.

House 6.—Two cases had developed here in the spring of 1915. The first was in a white woman of 27, who had had a typical attack since March of 1915. Her son, aged 16 months, had had a typical eruption since about the first of August, 1915. The family had lived in this house 3 years.

House 7.—This was a case of pellagra in a white woman, aged 66, who had had her first symptom in 1911, when living in House 8. After that she had been living in the country, but had returned to the city two months since. The disease seemed quiescent. A grandchild living in another part of the city had developed pellagra in the spring of 1915.

House 9.—A white woman of 70, who had lived for many years in another part of the city, had died here, the home of her brother. The wife of her nephew lived in House 10. This patient was 31 years old, and had had pellagra for some years. She associated constantly with the patient in House 6.

House 11.—A colored woman, 29 years old, had died here in 1914. No history could be obtained.

House 12.—A patient had died here in 1913. No history was to be obtained except from the patient in House 7, who it will be noted, had lived near by (House 8) and had associated with her.

House 13.—Three cases had developed here in 1913, and one of them, a child, had died. It is possible that the husband of the family also had had pellagra, but the history is uncertain. The family was living in another part of the city and the mother and daughter were seemingly well. Their neighbor in House 14 had developed pellagra at the same time. The woman had remained mentally affected; the small boy still had occasional attacks of diarrhea. The husband who had deserted the family, was said to have had a bad stomatitis at the time that the wife and the boy had had the symptoms. An infant of 14 months had died in the summer of 1915 of pellagra.

House 15.—In November, 1913, an old man, 74 years of age, had come here from Hillsdale, Simpson county, Ky., with evidences of pellagra, altho a marked eruption had appeared only in 1914. He had lived here with his daughter and had died in June, 1914.

House 16.—Two doors beyond in House 16, a family containing 5 children and 2 adults, had moved in, November, 1914, remaining there until July, 1915. The father, aged 37, had developed pellagra in March, 1915. In June and July, 3 girls, aged 11, 13, and 15 respectively, had developed pellagra. A boy, aged 2, had died in the spring from enteritis and had had a bad stomatitis, but no skin

lesions had been noticed. No physician in attendance. At the time of the survey, the family were living elsewhere.

House 17.—In the spring of 1914 another case had developed here. This was in a white woman of 28, who at the time the history was obtained was in a fair state of health. She had moved to House 18. A daughter, aged 10, was suffering from a stomatitis.

House 19.—A white woman 40 years of age had died during 1914 in this house. No history obtained as to onset.

A rather isolated community is that shown in Chart 16, in which the sequence of cases is rather striking. The district under consideration consists of a square block, divided in the center by a narrow alley.

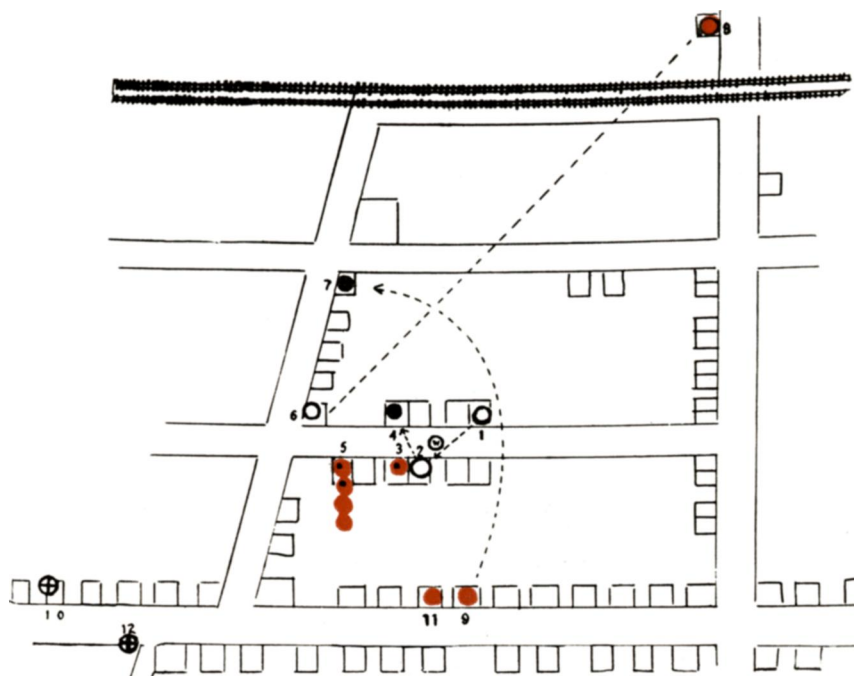


Chart 16. A striking sequence of cases of pellagra. See Chart 14 for the color key.

In this alley-way 5 double tenements are located, and a well (designated W in a small circle) supplies these families and several of the adjoining houses with water. All of these families constantly intermingle, visiting back and forth. There is no sewerage.

House 1.—In 1912 a white woman of 50 years had come here from Lebanon, Tenn. For 2 years previous she had had burning sensations in the stomach, and a tendency toward diarrhea. About 2 years before, she had first had a severe attack of diarrhea, had been very nervous, and had suffered from headaches.

Her mouth had been sore at times and at the time her history was taken she was salivated. The eruption on the hands was typical, but she did not recall the exact time of the onset. We assume that she had the disease when she came to House 1, in 1912. In 1913 she had moved to House 2, and was now living in House 4.

House 3.—In a different part of the city was found a white woman of 37 who dated her first symptoms to 1912, when she was living in this house.

House 5.—In the summer of 1915 a white woman of 45 had developed pellagra in this house. Living as her boarder was a white man of 35, in good health until 1915; he had developed pellagra during the summer of that year. Two other cases had developed in the same house during 1915. One, a woman 28 years of age, the daughter of the woman first mentioned, had developed symptoms of pellagra in the spring. She now lived with her friend a white woman of 32, at a different location. This latter woman had also developed pellagra while living in the house under consideration, but gave a history that her husband had died at an insane asylum and that her mother-in-law, with whom she had been living until she had come to House 4 in the spring, had pellagra.

House 7.—Another patient, a white woman of 38, who had developed pellagra in House 9 about 1 year before, now lived in this house.

House 8.—A white girl of 18 years lived here, who had developed pellagra in March, 1915. She gave a history of having had poor health since childhood, following an attack of typhoid fever. In January she had come from the country, and had then lived for 1 month in House 6.

House 10.—The only other patient in the neighborhood had been one that had died recently in this house. This had been a white woman. No history was to be obtained.

At the county asylum a woman had been admitted in the summer of 1915 suffering from pellagra. From the history obtained the symptoms dated from the summer of 1914, when the patient had lived in House 11. She had later moved to another address.

House 12.—A white man had died here in 1912 from pellagra.

Chart 17 also illustrates the sequence of cases of pellagra.

House 2.—Here there had lived a family with 3 pellagrous children during several months of the year 1914. The family now lived in East Nashville.

House 3.—Here, adjoining House 2, had lived a patient from the fall of 1914 to the summer of 1915. This patient (now in the city hospital for treatment for pellagra) gave the following history. She had had a severe diarrhea for 2 months past. About 4 years before she had had some scaling on both feet and on the inside of the hands, together with some indigestion. Ten years before (she was now 33) she had lived in Sumner county; at that time she had had a severe diarrhea, but gave no history of skin lesion. A number of neighbors had died of "flux" at that time. She now lived on an adjoining street.

House 13.—The patient here (history obtained at the city hospital), a white woman of 55, had had scaling on the back of her hands for several years and sore mouth every summer. Had been salivated 8 years before. The patient had occasional diarrhea and experienced difficulty in walking; was very nervous at times. Since Christmas she had lived in this house. The patient's mother had died from pellagra 8 years before.

House 12.—Here, across the street from House 13, lived a woman aged 27, who gave the following history: Seven years before she had had an eruption on the back of both hands, had been very nervous, and had had a stomatitis.

At the same time her father, mother, and sister had developed similar symptoms. Her friend, working with her as a clerk in a bank, had also had an eruption, diarrhea, and stomatitis. A sister-in-law was found in the survey with early symptoms and it was found that the mother and father of this

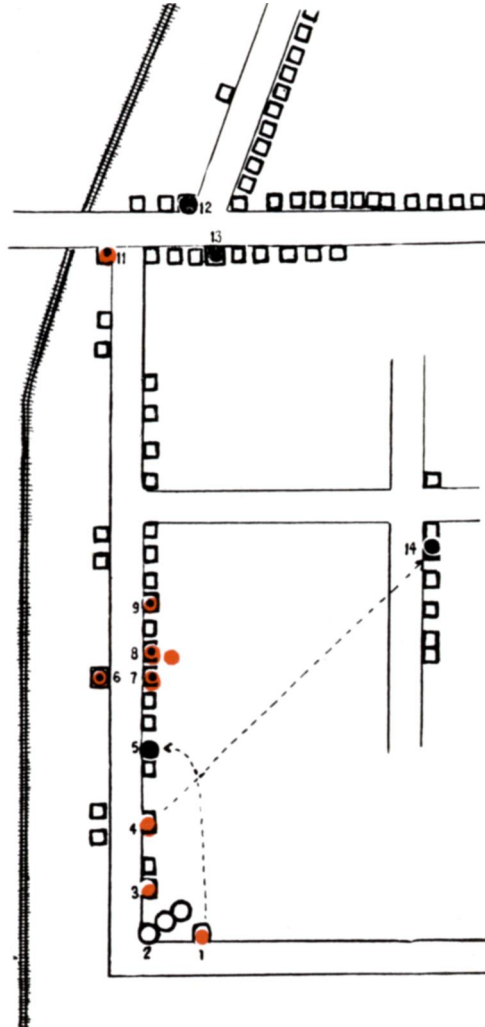


Chart 17. The sequence of cases of pellagra in an unsewered district. See Chart 14 for the color key.

latter woman had died in Nashville in 1910 from pellagra after coming from the country. The patient had lived in this house 1 year

House 11.—Here, diagonally across the street from House 13, a case had developed in 1914 in a white woman of 40; she was now in a fair state of health.

House 6.—A woman of 53, who had lived here for 18 years, stated that for years she had had scaling on the back of both hands in the summer time. For 2 years past she had felt very nervous and had had a stomatitis. She had always had an ample supply of milk, having kept a cow.

House 8.—Here, across the street from House 11, had lived a white woman of 48 for 11 years. In 1911 she had had an attack of diarrhea and stomach trouble; had had "eczema" on the back of both hands, had been nervous and she occasionally had a sore mouth. She was now in a fair state of health. Her daughter, a young woman of 22, living in Jackson county, Tennessee, had had a diarrhea and a skin eruption during the summer of 1915, some stomatitis, but no nervous symptoms. She was visiting her mother at this time. A grandchild (a white girl aged 6) of the older woman, living in an adjoining house (7), had developed pellagra during the summer of 1915.

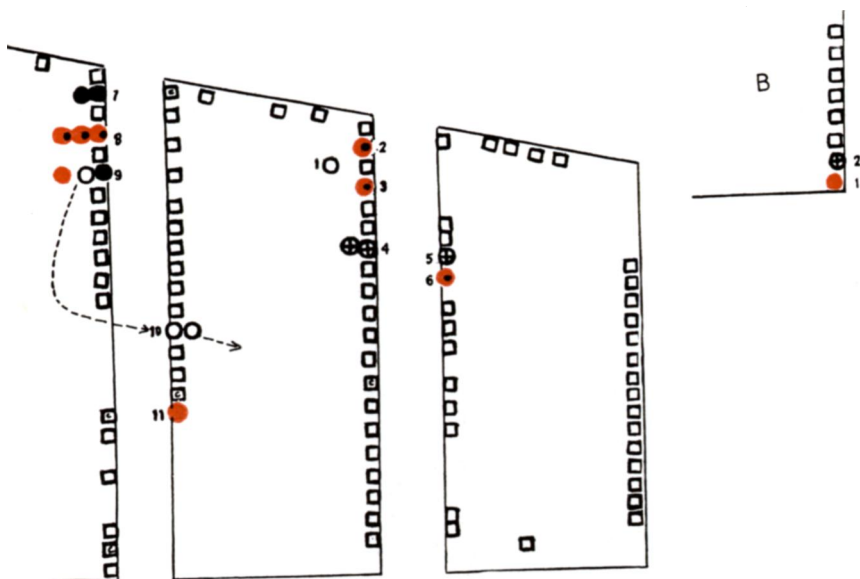


Chart 18. The sequence of cases of pellagra in an unsewered district. See Chart 14 for the color key.

House 9.—Here, a few doors away, another woman had developed skin lesions during this summer. No history was to be obtained from this patient.

House 5.—A white child of 2, who until recently had lived in House 1, had developed pellagra here in the summer of 1915.

House 14.—Here a white woman of 31, lived, who had developed mild skin lesions this same summer. Until 1 month before her history was taken, she had lived in House 4, for 18 months.

The entire district is unsewered.

Chart 18 illustrates the sequence of cases in another unsewered district.

House 1.—Here, in the rear of House 2, a pellagrin had lived during 1914—a white woman, 45 years of age, with the following history: The patient first had had symptoms of pellagra 4 years before while living in the country, near Goodlettsville. She had come to the city for a time in 1914, moving into the house noted here, and had remained until spring. She now lived with her daughter, who had recently developed pellagra. The friend of her daughter, a young woman of 24, had also developed pellagra.

House 2.—A girl of 14 lived here, who had moved here in March. At that time she had had an eruption on the back of both hands. The mouth was now typical. Previously this family had lived near some pellagrins on another street.

House 3.—A boy of 7 lived here, who during the summer of 1914 had had an eruption on both hands and feet, together with sore mouth and diarrhea. He was now in good condition.

One of the cases of longest duration had also been in this house—a girl of 16, who had died during the summer of 1915. She had developed symptoms of pellagra 12 years before, as a child, in the spring of 1903, while living at another place in North Nashville. At that time the skin lesions had been variously diagnosed as a "weeping eczema," "tetter," "seven-year itch," etc. The condition had continued, each year becoming worse, and at the last attack the mental condition had become very bad and had remained so until death. The family had lived here 6 years. There was one other child in the family with pellagra. This was a boy 2 years old, who had begun to have the typical eruption in February, 1915, and when examined (September) had had an eruption extending over the arms, shoulders, face, chest, and both legs. The child had been weaned at 1 year, but had had occasional breast feeding until February. The child had died in December, 1915. The mother showed no symptoms of pellagra, nor did the remaining child, a girl of 6.

If we go back for a moment to the former address of this family, where they had lived from 1903 to 1909, we find that according to the city death records a white woman of 70, died in the adjoining house in 1910 with a diagnosis of "dysentery and neurasthenia."

House 5.—Here, directly across the street from House 3, a white woman of unknown age had died in 1913 from pellagra. No information is available about this patient. In the adjoining house (6), lived a white woman of 34, who in the summer of 1915 had had all the symptoms of pellagra. According to the county health officer some of the children in this family had also had a pellagrous eruption. A niece of the patient, living in another part of the city, had pellagra.

House 7.—Two patients lived here. The older of these, a white woman of 67, a widow, had had pellagra for several years; she had come to Nashville 10 years before from Smith county, where her husband had died with symptoms which, as described, were pellagrous. She had lived here for a short time (4 months). Her daughter-in-law, a young woman of 25, had had pellagra for 3 or 4 years. She had had no attack during 1914, but had had an eruption in the spring of 1915. She had lived here 3 months, and before, in Smith county, where a neighbor, a cousin, had died from pellagra.

House 8.—A white woman of 30, living here, stated that in the spring of 1915 she had had a scaling eruption on the back of both hands, together with a severe diarrhea. She was very nervous. Had had no trouble like this before. Her two children, a boy of 8 and a girl of 11, had had mild symptoms in the spring of 1915.

House 9.—A case had originated here in the spring of 1915—in a girl of 3 years. The family had contained one other pellagrin. In the summer the family had lived for a short time in House 10, but had since moved, and were not found in the survey. In the same house there lived a man of 66, who had had mild symptoms of pellagra for several years, originating in DeKalb county. At a short distance was found a very severe case in a young negress, who in 1914 had lived for a time at House 11. She was a cook and had during recent times lived in various parts of the city.

Chart 19 illustrates the points of origin of several cases which have occurred during the past few years. At the time of the survey, only one of these was living on this street. She gave the following history:

House 1.—A white woman, 41 years of age, who had had her first eruption on both arms and a sore mouth in 1913. In 1914 she had had no eruption but had had a second eruption in 1915. She had lived in this house 8 years. A relation (Case 443, male, white, 59 years) had had pellagra for several years. He formerly had lived in the vicinity and now lived in South Nashville.

House 2.—Here, directly across the street from House 1, had been a case until 1913. The patient had then moved to House 9. She was a white woman, aged 36. She stated that she had had an eruption on both ankles in January, 1913, followed in March by sore throat, diarrhea, and indigestion. The eruption on the hands had appeared in April, 1913. She was in fair condition now, except for headache and rather bad memory.

House 3.—A white woman had died of pellagra here in 1912. No history could be obtained about this patient. In 1914 a white woman of 27, had developed pellagra in this house after living here 1 year. She stated that her husband's grandmother, an old pellagrin, had lived in the house with her and during this time she had had her first eruption. She had later returned to the country. This family was now in House 4.

House 7.—A case had developed here in 1913, during the spring, in a white woman, aged 42. She had been a friend and a frequent visitor of the patient living in House 9. In the autumn of 1915, this patient had moved to House 8 and had died there.

House 5.—A patient had lived here in 1913, had moved during the latter part of the year to House 6, and there had died during the same year. A sister-in-law (Case 831) living in North Nashville, stated that she had had a skin eruption and sore mouth for several years. One other case had died in the neighborhood, in House 10 (1914). No details were to be obtained about this case, nor about a patient who had died in 1911 in House 11.

The sewerred area is shaded.

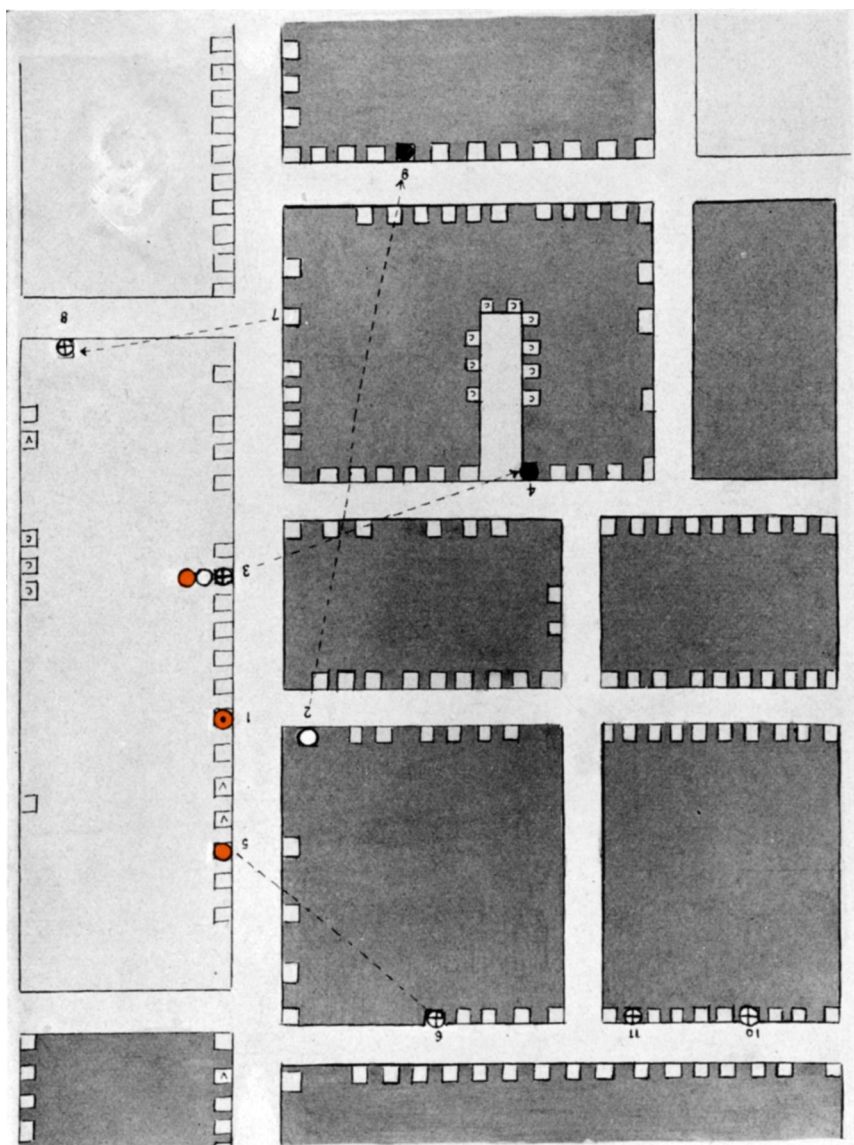


Chart 19. The points of origin of several cases of pellagra. The same color key is used here as in Chart 14.

In Charts 20 and 21 two families are shown, both of which are in moderately good circumstances, and both of which have been under expert medical care and careful instructions as to diet for several years. There is no sewerage in the areas in which they live.

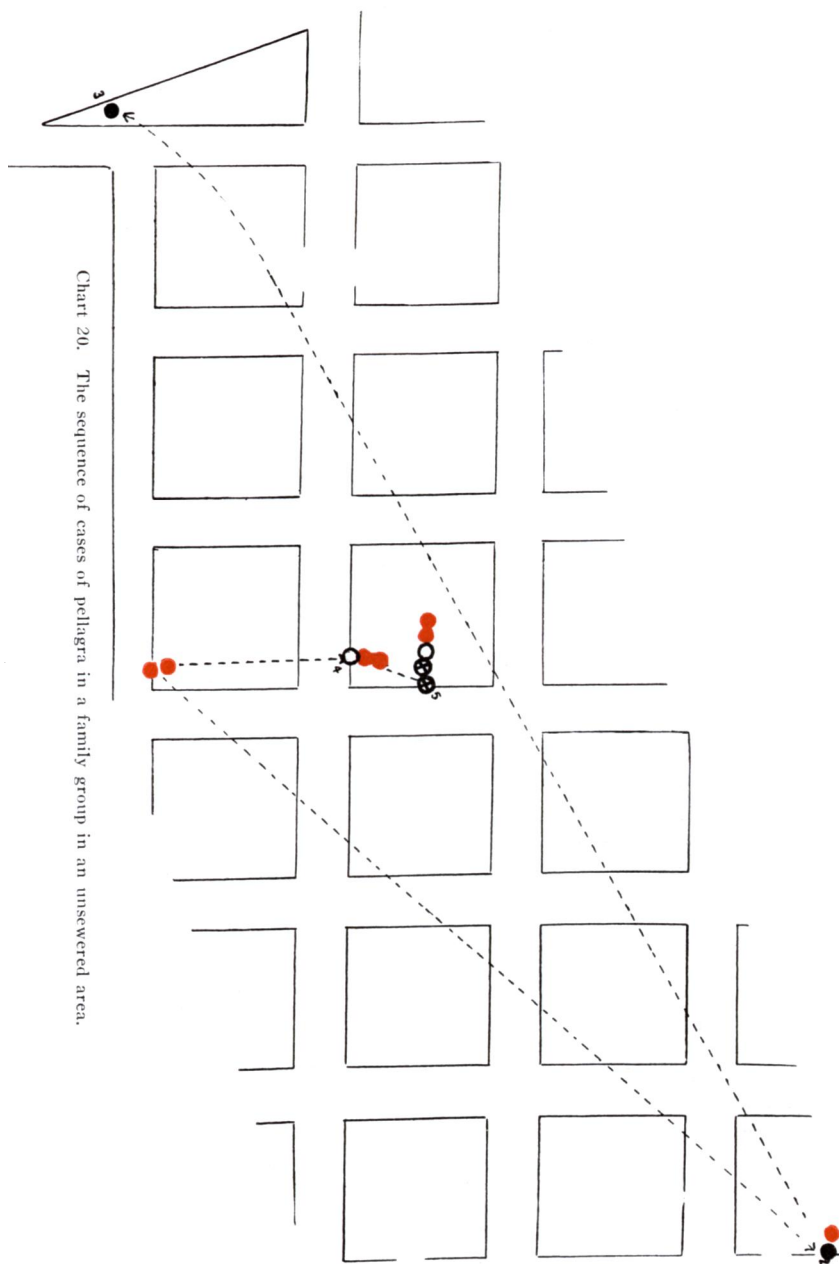
Chart 20.—In 1911 a young woman, 20 years of age, came from Huntsville, Alabama, where she had married a few years previously, to live in Nashville. While in Alabama she had nursed several friends who had pellagra. No members of her family had the disease at that time. She first lived in the house of her father-in-law (House 1) where she developed the disease shortly after her arrival. She remained here until the spring of 1914. During this time her sister came from Alabama, lived in the house for a time, and developed the disease there in 1914. She later recovered and now is living in House 2. In this house a third sister, now 19 years of age, lived with the second sister and while here developed symptoms of pellagra in the spring of 1915. She now lives in House 3.

In the spring of 1914 the original case moved with the father-in-law's family to the next street (House 4). Here both the father-in-law, a man of about 70 years, and the mother-in-law, aged 66, developed the disease. Later in the summer of 1914 the family moved to the next street, House 5. Here the father-in-law died, and his 2 younger children, aged 5 and 7 respectively, developed the disease. The mother-in-law was taken to the county asylum, where she died in 1914. The family has since moved from this house.

Chart 21.—A white woman 34 years of age, was taken ill in 1910 with a serious attack of pellagra. The family lived in House 1, having moved in from the country 2 years previously. The nearest neighbor on the farm in the country with whom the patient had frequently associated had been Mrs. E. R., who died 2 years ago in Franklin, Tenn., from pellagra, altho at the time of association the patient had not been aware that she had pellagra. The oldest son, aged 5, also developed the disease at the same time that his mother had. They were nursed by a woman living in House 2 who has remained well. The family remained in House 1 for another 3 years, then moved to House 3 (1914), where the patient had another severe attack, almost dying. At the same time the younger son developed a mild case of pellagra. Immediately across the street, in House 4, lived the sister-in-law. In this family the oldest son, aged 9, developed typical skin lesions in the summer of 1914, altho, as the mother stated, he might have had some eruption a year or so before. In the spring of 1915 the sister-in-law developed typical skin lesions and had a severe stomatitis.

After the original patient had recovered in the fall of 1914, the family again moved, this time to House 5, where they have lived since September, 1915. In House 6 adjoining, a mother and her 3 children all developed mild lesions in the spring of 1915. They have recently moved. A brother-in-law of the original patient, together with his child, have recently developed pellagra (examined by the county health officer) but the present address is unknown.

There is only 1 other case in the immediate neighborhood—a white woman, aged 33, who has been "nervous" since 1914 and had a "sunburn" on both arms



for the first time in the spring of 1915. Two years ago there lived for 2 weeks in her home a woman who was ill, and who was taken north, after a diagnosis of pellagra had been made. It is believed that she has recovered.

In 1914 a patient, it is said, lived in House 8 for several weeks.

In 1911 a case of pellagra originated and terminated fatally in House 7.

The wells which supply the families are indicated by small circles.



Chart 21. The sequence of cases of pellagra in a family group in an unsewered area.

RURAL SURVEY

During the summer (July and August) of 1914 a careful sanitary survey of a rural district adjacent to Nashville was made under the direction of the county health officer by Dr. W. B. Garner and Dr. T. V. Woodring.

In this surveyed area, which lies north of Nashville and includes all of the 10th and part of the 14th county districts (Chart 22), about 385 houses were visited and approximately 1725 individuals examined for pellagra. In this number 1592 were whites and 131 negroes; the average number of inhabitants to each house was 4.5, the same ratio that was found for Nashville.

The surveyed area is representative of the country surrounding Nashville. Parts of the district are comparatively fertile; others, sparsely inhabited portions, are rather barren. The crops consist largely of small grains, tobacco, and corn; stock and dairy interests are negligible; there are no manufacturing plants of any kind in the region.

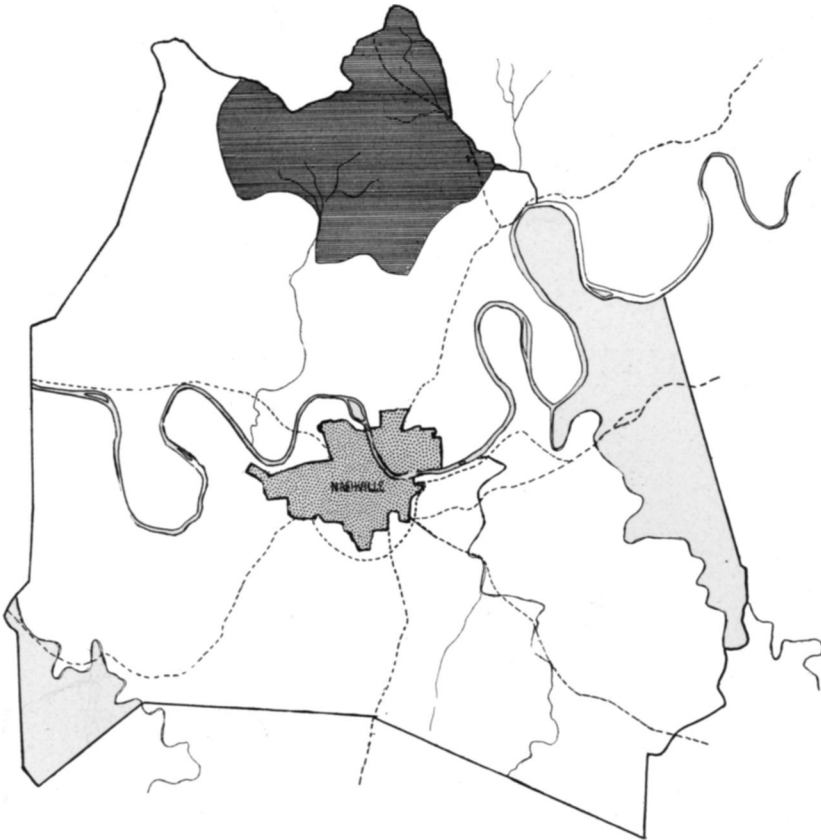


Chart 22. Map of Davidson county showing extent of the rural survey.

The sanitary conditions are probably better than in the average southern rural community, but of the total white population about 85% live in houses where absolutely no provision has been made for the disposal of human excreta. Of the total negro population of this area (131), only 3 families live in houses with access to privies.

In the surveyed area we found 39 cases of pellagra, all among the white race, representing about 2.5% of the total white population. These 39 cases occurred in 29 houses, 13 of which had no provision for the disposal of excreta, the rest having open privies. The total number of people living in these houses was 125. Of the 39 cases, 26 occurred in males and 13 in females. The age distribution is shown in Table 2.

TABLE 2
DISTRIBUTION OF CASES OF PELLAGRA ACCORDING TO SEX AND AGE

Ages.....	5 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60	61 to 66	67 to 70	71 to 75	76 to 80
Males....	2	1	2	1	0	1	4	5	2	1	2	2	1	0	2
Females..	1	1	1	0	1	4	2	2	0	0	0	0	0	1	0

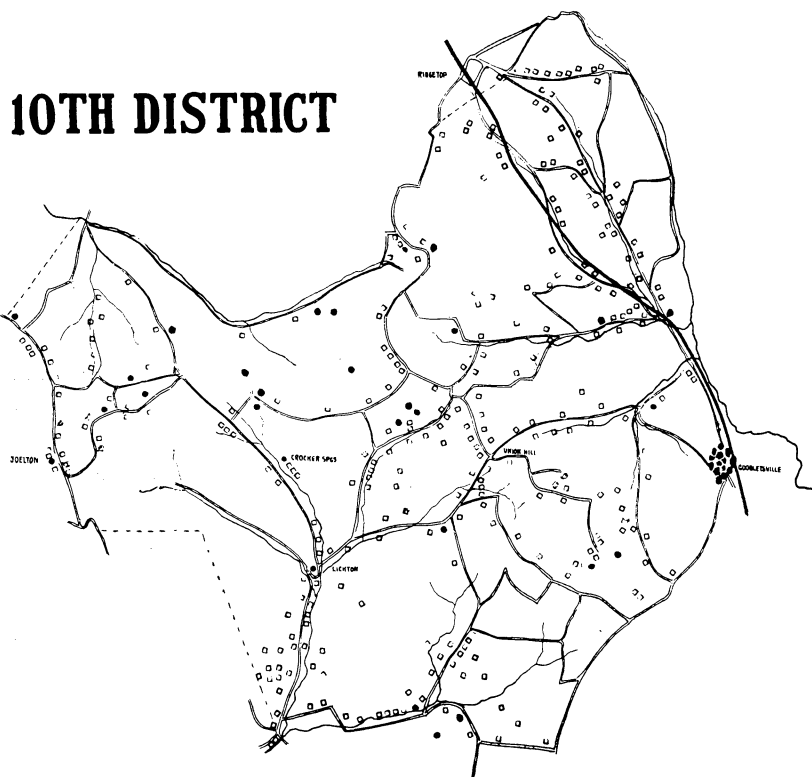


Chart 23. The grouping of pellagrous houses in the surveyed area shown in Chart 22.

It will be noted that the ratio of males to females is quite the reverse of that found in the city survey.

In Chart 23 the pellagrous houses have been indicated on a map of the surveyed area. The invariable grouping of 2 or 3 adjacent houses is evident.

The majority of the observed cases are of recent origin, dating back not more than 3 or 4 years at the outside. As far as we are able to determine there has been no alteration in the diet during this time, altho the diet is no doubt far from ideal. Carbohydrates and fats predominate; during the summer considerable quantities of fruits and leguminous vegetables are added. In some respects the diet of these rural families has deteriorated during the past 20 years on account of the absence of small game, due to the exhaustion of the timber supply, which formerly offered a ready means of augmenting the family budget; and on account of the unfortunate substitution of canned goods in the dietary in place of vegetables produced on the place. At present the diet consists largely of fat meat, ham, and occasional fowl, potatoes, beans, turnip greens, fresh onions, and fresh fruit. About one-half of the families use corn products; the other half, wheat flour for bread and biscuits. Most of the families have a cow, so that considerable milk is consumed, but very few eggs are used. In quantity this diet is possibly superior to that of the city worker, but it is somewhat less varied and undoubtedly contains less fresh meat.

DISCUSSION

The data gathered during the progress of the survey indicate that pellagra has been present in this locality for a longer time than is generally believed. If the information obtained from one patient is correct, she had her first attack in 1891, but the results of our work lead us to believe that most of the cases developed subsequent to 1907, and a great majority within the past 2 years.

It has been said that pellagra was just as prevalent in the latter part of the nineteenth century and earlier part of the twentieth century as it is as present, but that it was not recognized as an entity and that the majority of cases have since died.

This assertion is, we believe, disproved by the evidence submitted by Dr. West and Dr. Tucker. Their intimate knowledge of the health conditions of this locality obtained in their capacity as public health officials during the past 10 years, gives them the right to speak

with authority on this phase of the subject. That it was not prevalent in 1909 is shown by the results of the investigation of several of the local state and county institutions by Dr. Lavinder of the U. S. Public Health Service. Dr. Lavinder at that time expressed the opinion that pellagra would probably be found in most, if not all, of the charitable institutions in this locality, but after a careful examination he was unable to find a single case in any of the institutions examined. This is important, because as a result of a very cursory physical examination of the inmates of one of the same insane asylums we found nearly 30 cases—approximately 10% of the inmates. Special significance is attached to these findings as a certain number of those afflicted with pellagra become insane and must be confined to asylums; therefore, Dr. Lavinder's failure to find a single case in 1909 and our results in 1915, may be taken to indicate that the disease has become much more prevalent.

The area of the city surveyed contains about half of the population of the city, or approximately 65,000 people. It includes sewered and unsewered areas, and people whose economic condition ranges from the worst to the best.

In the course of the work it became evident that the disease is not distributed uniformly throughout the population, but that it is confined more or less to certain areas. This localization cannot be satisfactorily explained by the economic condition of the people in these particular areas, as those in similar circumstances living in houses separated by open ground, but several hundred yards distant, are not affected.

The most striking fact brought out by the survey is the relation the disease bears to sewered districts. Chart 11 (p. 537), which shows the origin of the cases, demonstrates this most conclusively. This map is incorrect in that it indicates that many of the older cases originated in sewered districts, when, as a matter of fact, the districts were not sewered at the time these cases developed. It has been interesting to note how the number of cases originating in a given area rapidly decreased subsequent to the installation of sewers. Moreover, many of the cases now living in sewered areas developed the disease elsewhere. Our observation that the disease is much more frequent in unsewered districts confirms that of the Thompson-McFadden commission.

In criticism of the report of the Thompson-McFadden commission it has been said that the people living in houses connected with sewers

were better off economically than those living in houses not connected with sewers, and that this explained the difference in morbidity; the supposition being that the rent of the former was higher than that of the latter. This criticism, however, certainly does not hold true for the surveyed area in Nashville, where there are what are termed "alley sewers." The privies in these instances are situated in the rear of the lot close to the alley along which the sewer runs, and each contains the usual "flush basin." Inquiries were made of the local real-estate agents who had charge of these houses, as to rents, etc., and it was found that there was no difference in the rent of houses of the same size, regardless of their sewer connections. At least 60% of the houses in sewered districts had sewer connections of this character, and as the rent is the same, it can hardly be said that these people are better situated economically. It is also the type of sewer connection, the installation of which apparently has been instrumental in materially lowering the morbidity in certain localities.

Little need be said about the age of the patients. Children do not appear to be as susceptible as adults, and this is particularly true of children during the second decade of life. After the second decade women are affected from 3 to 4 times more frequently than men, though from 50 years on both sexes appear to be equally susceptible. These results conform closely with reports made by others, both in this country and abroad, and particularly with the statistics published by the Thompson-McFadden pellagra commission. It is interesting to note that these proportions are exactly reversed for the 10th sanitary district, where it was found that more men than women were affected.

Of the total number of cases of whom we could obtain any record, 785 were white people and 235 were negroes, a proportion of 3 to 1. These figures indicate that negroes are just as susceptible to the disease as white people, as the proportion of colored to white people is the same for the population of the city. However, this does not hold true for our survey, as we found that 1 in 106 white people were affected and 1 in 185 colored people. The data obtained during the survey make it appear that the mortality is higher among negroes than among white people. This, if true, would explain the disparity in figures just noted.

The figures given in some reports indicating that negroes are more susceptible than whites can probably be interpreted as more relative than actual, the disproportion being due possibly to the fact that there are more negroes than whites living in these localities.

The majority of the patients had their attacks during the spring and summer months, the white people most frequently during the spring, and the colored people during the summer months. Many of the patients complained of having suffered for some time previous to the acute attack with symptoms referable to the gastro-intestinal tract. Whether or not these symptoms may be considered as belonging to the early stages of the disease, or as merely coincidental, remains to be determined. Nervousness is another symptom which may precede the attack for weeks and sometimes for months.

Practically half of the patients whose histories we could obtain first developed the disease in 1915, while 14% had their first attack in 1914. Thus it will be seen that nearly 65% of the cases have developed within the past 2 years. It is possible that these figures do not give the real facts, and that the disease has been more prevalent in the past than they indicate. If this is true, the mortality in the past must have been greater than it is at present. However, the reports of Dr. Tucker and Dr. West and information obtained during the survey make us believe that these figures represent the real conditions as they exist in Nashville.

We are unable to form even an approximate idea of the mortality, because of the fact that we do not know how many cases have really developed during the past 2 years. That we have not found all the cases in the surveyed area we feel certain, and until such exact information is obtained, it is useless to hazard a guess as to the proportion dying.

It is evident that the inhabitants of the South consume excessive amounts of carbohydrates and fats. Corn in the form of corn-bread and grits has been used a great deal, but it is being gradually supplanted to such a degree in many pellagrous families by wheat flour that it can hardly be considered as an etiologic factor.

Proteins do not occupy the important place in the diet that they do in the northern sections of the country. However, if the data which we have collected are correct, the amount consumed by 68% of our cases is considerably more than sufficient to sustain them. This view is based on the experiments of Chittenden,⁶ and the observations of McCay,⁸ both of whom found that individuals getting 40 gm. of protein a day do not develop pellagra. It is very probable that a low protein intake does lower resistance; other faults in diet would probably have the same effect. The criticism may be made that the patients and their friends misled us as to the amount of proteins consumed,

but even if we accept the statements of only half the 60%, we still have 30% of the patients who have received much more than 40 gm. of protein a day. Experiments are now being conducted which we hope will give us more specific data on this phase of the subject.

The valuable work done by Goldberger and his associates³ shows that a properly balanced diet is one of the most efficient means of preventing the development of pellagra. However, it must not be forgotten that poorly nourished individuals are prone to contract many diseases. Certainly our results indicate that other conditions must also be considered in determining the etiologic factor.

Funk¹² has advanced the theory that pellagra is due to a deficiency in vitamins. He states that the disease is caused by the excessive use of devitaminized corn, and that it may be prevented by the addition of vitamin-containing substances, such as potatoes, milk, butter, fruit, etc. The people in this section of the country, however, eat a great deal of potatoes, fruits, and other green foods, both cooked and raw, during the spring and summer. It seems strange, if this theory is correct, that pellagra should be rare in the winter when green foods are scarce, and so frequent in the spring and summer when green foods and fruits are plentiful and cheap.

One of the most striking facts brought out in the investigation is the close association of the pellagrous areas with the unsewered districts. A number of pellagrins were found in houses with sewer connections, but the majority of these had either recently moved from unsewered districts, were living in houses adjoining such districts, or were in the habit of visiting friends and relatives who had the disease in other parts of the city.

The sanitary conditions present in these localities are frequently of the worst possible character with regard to sewage-disposal. Many of the privies have vaults, but these are rarely cleaned and are almost never enclosed so as to prevent the entrance of flies. In many instances, however, there are no vaults, and here but little pretense is made to do anything with the excreta, which are usually covered with flies, the chickens and hogs acting as the scavengers. A few of the privies were properly cared for, but these cases were in the minority.

Screening was absent from nearly all the houses and where present, was usually full of holes.

¹² München. med. Wehnschr., 1914, 61, p. 698.

Information obtained from the real-estate men shows that rents for these small houses are the same in a given locality, regardless of whether the houses are connected with sewers or not. This indicates that those living in the houses having sewer connections need not be of different social strata, a view confirmed by those making the survey.

In view, then, of the fact that no other difference could be found between the people in the unsewered and those in the sewer areas to explain the greater prevalence of the disease among the former, it appears that the lack of proper sewage-disposal must play an important part in the development of pellagrous centers. It is also very suggestive that the typhoid incidence, with one exception, conforms closely with that of pellagra.

We were unable to find that water bears any relation to the disease. City water, and water from wells, springs, and cisterns was used indiscriminately, without any apparent influence on the incidence of the disease. The well and spring water is "hard water," because of the presence of lime salts; this would tend to disprove the theory advanced by Allesandrini and Scali¹¹ that the disease is due to the presence of colloidal silicates, which are removed by adding lime.

Another striking fact brought out in the survey is that 78.8% of the patients had been in intimate contact with other pellagrins before they themselves had developed their first attack. Of this series 33 $\frac{1}{3}$ % of the pellagrins developed the disease in houses in which there were other patients; 18.7%, where there were cases in the adjoining houses; 19.3%, where there were patients in the same block with whom they associated; and 7% visited patients elsewhere or were associated with them in their daily occupations.

These figures may be interpreted in two ways: first, that pellagra develops only in those who have been exposed to the disease, and second, that the high percentage of contacts is purely fortuitous, without significance as far as the etiology of the disease is concerned. We are not in a position yet to say which of these two possibilities is the correct one, and we believe that it would be fruitless to attempt any discussion until more proof has been obtained.

In its distribution the disease bears no definite relation to the density of population. It was formerly thought that pellagra was a disease confined more or less to rural districts, but our experience shows that it also occurs in thickly settled communities.

The present report on the epidemiology of pellagra will be followed by another dealing more specifically with certain phases of the etiology of the disease.

CONCLUSIONS

A few cases of pellagra were probably present in Nashville in 1891, but the disease did not become prevalent until 1908. About 65% of the cases found in the survey developed during 1914 and 1915. Approximately 89% of the pellagrins developed the disease while residing in houses which were not connected with sewers, and 95% of these had unscreened vault or surface privies in close proximity to the house. Only 2% of the houses were screened. The typhoid incidence corresponds with that noted for pellagra.

More than 78% of the patients had associated with other patients before they developed the disease. Thus, 33% of the pellagrins developed the disease in houses which contained other cases, while in most of the remaining instances there were patients in the adjoining houses or within the same block with whom they constantly came in contact.

The water used was derived from various sources; it can therefore hardly be considered an important factor in the development of the disease.

White and colored races appear to be equally susceptible. More white people than colored people develop the disease in the spring. The reverse holds true for the summer months. The mortality appears to be greater in the negro race. Relatively few cases were found among negro children.

Individuals from 10 to 20 years of age are less susceptible than at any other period of life. Women 30 to 50 years of age are from 3 to 4 times more susceptible than men. Over 50 years and under 10 years, both sexes are equally susceptible. In the rural district surveyed, more men than women were affected.

The diet contains an excess of carbohydrates, but 68.8% of the patients gave histories indicating that they were consuming proteins in considerable excess of 40 gm. a day, an amount which has been shown to be sufficient to sustain life without the development of pellagra.